PROPERTY OF
A. A. C. P.
OFFICE OF
SECRETARY

PROCEEDINGS

of

Teachers Seminar On Pharmacology

And Related Subjects

VOLUME I

Held Under The Auspices

of

The American Association of Colleges

of

Pharmacy

at

Purdue University School of Pharmacy

July 9-14 inclusive, 1951

Edited By

Glenn L. Jenkins

The Teachers Seminars Are Made Possible
By The Support Of

THE AMERICAN FOUNDATION FOR PHARMACEUTICAL EDUCATION

August 15, 1951

PROPERTY OF
A. A. C. P.
OFFICE OF
SECRETARY

VOLUME I

VOLUME I

PROCEEDINGS

of

TEACHERS SEMINAR ON PHARMACOLOGY

AND

RELATED SUBJECTS

Held Under the Auspices
of
The American Association of Colleges
of
Pharmacy

at

Purdue University
School of Pharmacy

July 9-14 inclusive, 1951

Edited by

Glenn L. Jenkins

The Teachers Seminars Are Made
Possible By The Support
of
The American Foundation For Pharmaceutical Education

August 15, 1951

PROCEEDINGS

of

TEACHERS SEMINAR ON PHARMACOLOGY

AND

RELATED SUBJECTS

Held Under the Auspices
of
The American Association of Colleges
of
Pharmacy

at

Purdue University
School of Pharmacy

July 9-14 Inclusive, 1951

Edited by

Glenn L. Jenkins

The Teachers Seminars Are Made
Possible By The Support
of
The American Foundation For Pharmaceutical Education

August 15, 1951

INTRODUCTION

The Proceedings of the "Seminar on Pharmacology and Related Subjects" constitute about as detailed a report as can be prepared. Some of the papers as presented are given completely and others are given in outline or abstract form. It is regrettable that the discussions and detailed descriptions of the demonstrations cannot be included.

A copy of this Proceedings is being mailed to each registrant. Two copies are being sent to each college of pharmacy in the United States, one for the college library and the other for the Head of the Department of Pharmacology.

The Seminar was held under the auspices of the American Association of Colleges of Pharmacy and was made possible by a grant of funds from the American Foundation for Pharmaceutical Education. Purdue University made its facilities and equipment available without charge except for room and board. Many firms contributed faculty to the program and prepared exhibits or demonstrations. All of them deserve our thanks. Particular mention should be made of the excellent cooperation of Eli Lilly and Company which made available from its pharmacology department five individuals for lectures and fifteen for demonstration participation and supplied all personnel, equipment, animals, and drugs for these without charge.

It is impossible to convey in a proceedings the fine spirit of cooperation by the registrants, the careful preparation and able presentation by members of the faculty, the well planned and expertly performed demonstrations, and the details of planning and execution of tasks that made the Seminar highly successful. Only those who were present could appreciate the diligent effort, intelligent selection of subject matter, prompt and regular attendance at meetings, and the general superior esprit de corps that prevailed.

The Committee is of the opinion that the Seminar was highly successful and that the program carried out will accomplish the objective to upgrade the quality of instruction in pharmacy schools. This upgrading as it gains momentum in the years ahead will bring improved teaching to successive generations of students. In time a greater profession giving increased services to the people will result.

The Seminar was attended by 193 registrants and participants who came from 65 different colleges and universities and 17 industrial companies. Thirty-two states and the District of Columbia

were represented. Among the colleges and universities represented were 4 from Canada, 2 from the Philippine Islands, and 1 each from Egypt, India, and Japan.

The Committee thanks all who participated in the Seminar and aided in the program. Special thanks are expressed to the American Foundation for Pharmaceutical Education for the vision and understanding of its leaders that led them to provide the funds that made the Seminar possible. It is hoped that donors to the Foundation may become fully aware of the excellent purposes and worthwhile uses their contributions serve through such activities as this Seminar.

Respectfully submitted,

THE A.A.C.P. COMMITTEE ON SEMINAR

Joseph B. Burt
Leroy D. Edwards
K. K. Chen
Hugo H. Schaefer
Louis C. Zopf
Glenn L. Jenkins, Chairman

CONTENTS

Introduction

Program

Faculty and Committees

Additions and Corrections

Registrants and Participants

Papers in the order in which they appear in the program

Introduction

Program

Faculty and Committees

Additions and Corrections

Deleterate and Participants

Papers in the order in which they appear in the program

TEACHERS SEMINAR ON PHARMACOLOGY AND RELATED SUBJECTS

July 9-14 inclusive, 1951

To be held in Room 311

School of Pharmacy, Purdue University

PROGRAM

Monday Morning, July 9, Dr. L. D. Edwards, Presiding.

9:00 Registration.

9:30 Announcements, Welcome, and Objectives of the Seminar.
Dr. Glenn L. Jenkins, Chairman of Seminar Committee, Purdue University.

10:00 The Need for a Thorough Understanding of Pharmacology in Professional Pharmacy Practice.
Dr. Don E. Francke, University Hospital, University of Michigan.

10:30 Discussion.

10:50 Intermission.

11:00 The Objectives of Pharmacology in the Pharmacy Curriculum.
Dr. Frank T. Maher, University of Illinois.

11:30 Discussion.

11:45 Lunch.

Monday Afternoon, July 9, Dean Hugo Schaefer, Presiding.

1:00 Minimum Prerequisites for the Undergraduate Course.
Dr. Leroy D. Edwards, Purdue University.

1:40 Discussion.

2:00 Intermission.

2:10 Correlation of the Biological Sciences in the Pharmacy Curriculum.
Dr. R. A. Deno, Director of Educational Relations for the American Council of Pharmaceutical Education.

2:50 Discussion.

3:20 Intermission.

3:30 Tour of the Pharmacy Buildings and Visits to the Laboratories and Exhibits.

Monday Evening, July 9.

Visits to exhibits.

Tuesday Morning, July 10, Dean J. B. Burt, Presiding.

9:00 The Undergraduate Course -- Didactic.
Dr. H. G. O. Holck, University of Nebraska.

9:40 Discussion.

10:00 Intermission.

10:10 The Undergraduate Course -- Laboratory.
Dr. E. A. Swinyard, University of Utah.

11:00 Discussion.

11:15 Moving picture with color and sound - "Microtechnique".
Dr. F. A. Waterman, Wayne University.

11:45 Lunch

Tuesday Afternoon, July 10, Prof. L. C. Zopf, Presiding.

1:00 Physical Requirements for Pharmacological Instruction.
Dr. John W. Nelson, Ohio State University.

2:00 Discussion.

2:30 Intermission.

2:40 The Effect of Drugs on the Isolated Mammalian Heart.
A color film.

3:10 The Pharmacology Instruction of Pharmacy Students in a Medical School Department.
Dr. E. G. Gross, State University of Iowa.

3:50 Discussion.

4:00 Visits to exhibits.

Tuesday Evening, July 10, Dr. H. G. DeKay, Presiding.

7:30 Financial Support for Instruction and Research.
Dr. W. Paul Briggs, Director American Foundation for Pharmaceutical Education.

8:30 General discussion of the economic problems in building and operating a Pharmacology Department.

Wednesday Morning, July 11, Dr. F. T. Maher, Presiding.

9:00 Qualifications of Instructors.
Dr. H. G. O. Holck, University of Nebraska

9:30 Discussion.

9:45 The Elements of Good Teaching.
Dr. Paul Alexander, Purdue University.

10:15 Discussion.

10:30 Intermission.

10:40 The Correlation of Pharmacognosy and Pharmacology.
Dr. E. Ramstad, Purdue University.

11:15 Discussion.

11:30 General Discussion and Summary of the Findings Relative to the Undergraduate Course.
Dr. Nellie P. Watts, New England College of Pharmacy.

11:45 Lunch.

Wednesday Afternoon, July 11, Dr. John W. Nelson, Presiding.

1:00 The Mechanism of Drug Action.
Dr. K. P. DuBois, University of Chicago.

1:40 Discussion.

2:00 Intermission.

2:10 The Value of Biochemistry to Pharmacology.
Dr. R. C. Corley, Purdue University.

2:50 Discussion.

3:05 Intermission.

3:15 Teaching Endocrinology by the Experimental Method.
Dr. M. X. Zarrow, Purdue University.

3:50 Discussion.

4:00 Laboratory Demonstrations - Pharmacy Annex.

1. Toxic Action and Antidotes for Some New Pesticides.
   Dr. K. P. DuBois.

2. Hooker-Forbes Bioassay for Progesterone (Microinjector).
   Dr. M. X. Zarrow.

3. Pithed Rat Preparations.
   Dr. L. D. Edwards, T. S. Miya, and N. H. Adams.

4. Rat Tail Blood Pressure Method.
   Dr. L. D. Edwards and Dr. C. P. Headlee.

5. Action of Drugs on Circular Muscle of the Gut.
   Dr. L. D. Edwards, A. L. Picchioni, and R. J. Schlembach.

6. Assay of Posterior Pituitary - Chicken Blood Pressure Method.
   Dr. L. D. Edwards, D. C. Kroeger, and J. W. Dow.

7. Rat Meso-Appendix Preparation.
   Dr. L. D. Edwards, N. W. Dunham, and M. W. Jordan.

8. Rat Phrenic Nerve - Diaphram Preparation.
   Dr. L. D. Edwards, R. L. Bogner, and C. J. Bryant.

9. Bile Flow in Rats.
   Dr. L. D. Edwards and R. F. Banziger.

10. Tracheal Chain.
    Dr. L. D. Edwards and H. C. Ferguson.

11. Student Laboratory Experiment Demonstrating Biological Variation.
    Dr. Gross and Dr. Keasling.

12. Student Laboratory Experiment Demonstrating the Localization of Autonomic Drugs.
    Dr. Gross and Dr. Keasling.

Wednesday Evening, July 11.

8:00 Informal Reception, Faculty Lounge, Purdue Memorial Union.

Thursday Morning, July 12, Dr. G. J. Sperandio, Presiding.

9:00 The Activities of the Division of Pharmacology of the United States Food and Drug Administration.
Dr. Bert J. Vos, Federal Security Agency, Food and Drug Administration.

9:40 Discussion.

10:00 Intermission

10:10 Screening Program in the Industry.
Dr. K. K. Chen and associates (Dr. F. G. Henderson, Dr. H. M. Lee, R. C. Anderson, and E. Brown Robbins) Eli Lilly and Company.

11:30 Discussion.

11:45 Lunch.

Thursday Afternoon, July 12, Dr. E. Ramstad, Presiding.

1:00 Statistical Validity of Experimental Results.
Dr. Andrew C. Bratton Jr., Parke, Davis and Company.

1:30 Discussion.

1:45 Laboratory Demonstrations - Pharmacy Annex

1. Toxicity - Technique of Injection.
Dr. K. K. Chen and R. C. Anderson.

2. Analgesics - Rat Tail Method and Hardy-Wolff-Goadell Method.
Dr. K. K. Chen and E. Brown Robbins.

3. Cardiac Drugs - Frog Perfusion, Cat Electrocardiogram, and Pigeon Assay.
Dr. K. K. Chen and Dr. F. G. Henderson.

4. Aerosol Method for Antihistaminics, the Thiry Fistula Dog.
Dr. K. K. Chen and Dr. H. M. Lee.

4:00 5. The Hanging Rat Cage Method for Estimating the Central Nervous Stimulant Action of Drugs.
Dr. M. J. Vanderbrook and Mr. Boyd Graham.

6. Recording the Heart Beat of Warm Blooded Animals.
Dr. J. W. Nelson.

7. Adaptation of the Hiner Frog Heart Chamber.
Dr. J. W. Nelson.

8. Paper Chromatography.
Dr. E. Ramstad, W. E. Wright, and G. F. Collins.

9. Photoelectric Plethysmograph.
Dr. M. X. Zarrow.

10. Positive and Negative Vaginal Smears.
Dr. M. X. Zarrow.

Thursday Evening, July 12, Dr. G. E. Cwalina, Presiding.

7:30 Radioactive Tracer Technics in Teaching and Research.
Dr. John E. Christian, Purdue University.

8:10 Growing Radioactive Medicinal Plants - (Slides).
Dr. K. P. DuBois, University of Chicago.

8:20 Discussion. (Leader, Dr. K. P. DuBois.)

8:30 Demonstrations of Radioactive Isotope Utilization.
Dr. John E. Christian.

1. Iodine Uptake in Blood and Thyroid.
H. S. Bailey.

2. Phosphorus Distribution (Radioautographs).
D. W. Blackburn.

3. Measuring and Monitoring Instruments.
J. P. Buckley, J. A. Campbell, and C. M. Foltz.

4. Restricted Blood Flow Detection.
H. H. Hutchins.

5. Drug Distribution Studies (Sulfonamide).
L. P. Sinotte.

6. Quantitative and Qualitative Analysis of Medicinals.
N. E. Webb and E. E. Hamlow.

7. Radioisotope (Ag^{108}) Production.
W. E. Wright and G. F. Collins.

Friday Morning, July 13, Dr. K. K. Chen, Presiding.

9:00 Applications to Animal Science.
Dr. F. N. Andrews, Purdue University.

9:40 Discussion.

9:50 Intermission.

10:00 Graduate Instruction. (A Panel Discussion).
Objectives. Dr. Harold W. Werner
Qualification of Staff and Students. Dr. E. A. Swinyard.
Choice of Problems. Dr. B. E. Abreu.
Graduate Courses. Dr. L. D. Edwards.
The Graduate Seminar. Dr. F. T. Maher.

11:45 Lunch.

Friday Afternoon, July 13, Dr. J. E. Christian, Presiding.

1:00 Toxicology--Instruction and Practice.
Dr. C. W. Muehlberger, Michigan State Toxicologist.

1:40 Discussion.

1:50 Intermission.

2:00 The Common Ground of Human and Animal Diseases.
Dr. L. M. Hutchins, Purdue University.

2:40 Discussion.

2:50 Intermission.

3:00 The Pharmacology Research Group in Industry.
Dr. Barbara B. Brown, The Wm. S. Merrell Company.

3:40 Discussion. (Leader, Dr. Wilbur M. Benson, Hoffmann LaRoche, Inc.)

4:00 Ganglionic Blockade of Cervical Sympathetic Nerve. A color film.
Dr. H. Werner, The Wm. S. Merrell Company.

4:20 Other Audio-Visual Aids or Demonstrations.

Friday Evening, July 13.

Visits to exhibits.

Saturday Morning, July 14, Dean Glenn L. Jenkins, Presiding.

9:00 General Discussion.

1. Future Manpower Needs in Pharmacological Teaching, Control, and Research.
Dr. Glenn L. Jenkins.

2. **Research Teamwork in Industry, in Colleges, and Cooperation between Colleges and Industry.**
   Drs. Abreu, Werner, Bratton, and Benson.

3. **The Standards of the American Council on Pharmaceutical Education.**
   Dr. R. Deno, Rutgers University.

4. **The Combined Pharmacology-Pharmacognosy Department.**
   Dr. Nellie P. Watts, New England College of Pharmacy.

5. **Miscellaneous Problems for the Floor.**

6. **Summary of Findings of the Seminar.**
   Dr. L. D. Edwards.

11:45 **Adjournment.**

FACULTY FOR TEACHERS SEMINAR ON PHARMACOLOGY AND RELATED SUBJECTS

ABREU, BENEDICT E., M.D., Ph.D., Pharmacologist and Associate Director of Research, Pitman-Moore and Co.

ALEXANDER, PAUL Ed. D., Associate Professor of Education, Division of Education and Applied Psychology, Purdue University.

ANDERSON, R. C., Pharmacologist, Eli Lilly and Co.

ANDREWS, FRED N., Ph. D., Associate in Animal Husbandry, Agricultural Experiment Station; Professor of Animal Husbandry, School of Agriculture; Assistant to the Dean of the Graduate School, Purdue University.

BENSON, WILBUR M., M.D., Ph.D., Pharmacologist, Hoffmann LaRoche, Inc.

BRATTON, Jr., ANDREW C., M.D., Ph.D., Director Pharmacological Research, Parke, Davis and Co.

BRIGGS, W. PAUL, LL.D., Director of American Foundation for Pharmaceutical Education.

BROWN, BARBARA B., Ph.D., Pharmacologist, The William S. Merrell Co.

BURT, JOSEPH B., Ph.D., Dean School of Pharmacy, University of Nebraska and Chairman of the Executive Committee of the A.A.C.P.

CHEN, K.K., Ph.D., M.D., Director of Pharmacological Research, Eli Lilly and Co.; Professor of Pharmacology, Indiana University School of Medicine; and President-Elect of the American Society for Pharmacology and Experimental Therapeutics.

CHRISTIAN, JOHN E., Ph.D., Professor of Pharmaceutical Chemistry and Coordinator of Bionucleonics Research, School of Pharmacy, Purdue University.

CORLEY, RALPH C., Ph.D., Professor of Biochemistry, School of Science, Purdue University.

CWALINA, GUSTAV E., Ph.D., Associate Professor of Pharmaceutical Chemistry, School of Pharmacy, Purdue University.

DENO, RICHARD A., Ph.D., Professor of Biological Sciences, College of Pharmacy, Rutgers University and Director of Educational Relations, American Council on Pharmaceutical Education.

DU BOIS, KENNETH P., Ph. D., Assistant Professor of Pharmacology, Toxicity Laboratory, University of Chicago.

EDWARDS, LEROY D., Ph.D., Professor of Pharmacology, School of Pharmacy, Purdue University.

FRANCKE, DON E., D.Sc., Chief Pharmacist, Michigan University Hospital; Director of the Division of Hospital Pharmacy, American Pharmaceutical Association; President-Elect of the American Pharmaceutical Association.

GROSS, ERWIN G., Ph.D., M.D., Professor and Head of Department of Pharmacology, College of Medicine, State University of Iowa.

HARDING, DONALD W., B.S., Assistant Professor of Pharmacy and Director of the Pharmacy Extension Department, School of Pharmacy, Purdue University.

HENDERSON, F. G., Ph.D., Pharmacologist, Eli Lilly and Co.

HOLCK, HAROLD G.O., Ph.D., Professor of Pharmacology, School of Pharmacy, University of Nebraska.

HUTCHINGS, LESLIE M., Ph.D., Head of the Department of Veterinary Science, Professor of Veterinary Science, School of Agriculture, Purdue University.

JENKINS, GLENN L., Ph.D., Dean and Professor of Pharmaceutical Chemistry, School of Pharmacy, Purdue University and Chairman of the Seminar Committee.

LEE, H. M., Ph.D., Pharmacologist, Eli Lilly and Co.

MAHER, FRANK T., Ph.D., M.D., Assistant Dean of Pharmacy and Professor of Pharmacognosy and Pharmacology, College of Pharmacy, University of Illinois.

MIYA, TOM, Instructor in Pharmacology, School of Pharmacy, Purdue University; Chairman of the Exhibit and Demonstration Committee.

MUEHLBERGER, CLARENCE W., Ph.D., State Toxicologist, Michigan State Health Department.

NELSON, JOHN W., Ph.D., Associate Professor of Pharmacy, College of Pharmacy, Ohio State University.

RAMSTAD, EGIL, Ph.D., Professor of Pharmacognosy, School of Pharmacy, Purdue University.

ROBBINS, E. BROWN, Pharmacologist, Eli Lilly and Co.

SCHAEFER, HUGO H., Ph.D., Dean and Head of the Department of Chemistry, Brooklyn College of Pharmacy, Long Island University; President of the A.A.C.P.

SPERANDIO, GLEN J., Ph.D., Assistant Professor of Pharmacy, School of Pharmacy, Purdue University.

SWINYARD, EWART A., Ph.D., Professor of Pharmacy, School of Pharmacy, University of Utah.

VANDER BROOK, M. J., Head Pharmacological Research Department, The Upjohn Co.

VOS, BERT J., Ph.D., M.D., Pharmacologist, U. S. Food and Drug Administration, Division of Pharmacology.

WATERMAN, FREDERICK A., Ph.D., Professor of Biology, College of Pharmacy, Wayne University.

WATTS, NELLIE P., Ph.D., Chairman of the Department of Pharmacology and Materia Medica, New England College of Pharmacy.

WERNER, HAROLD W., Ph. D., Director of the Scientific Laboratories, The William S. Merrell Co.

ZARROW, M. X., Ph.D., Associate Professor of Zoology, School of Science, Purdue University.

ZOPF, LOUIS P., Professor of Pharmacy, College of Pharmacy, Iowa State University; Secretary of the A.A.C.P.

COMMITTEES

PROGRAM AND GENERAL ARRANGEMENTS -

G. L. Jenkins, Chairman; J. B. Burt; K. K. Chen; L. D. Edwards; H. H. Schaefer; L. C. Zopf.

REGISTRATION, HOUSING, INFORMATION, AND RECREATION -

D. W. Harding, Chairman; G. E. Cwalina; J. B. Data; C. O. Lee; G. J. Sperandio.

DEMONSTRATIONS AND EXHIBITS -

T. S. Miya, Chairman; N. H. Adams, H. S. Bailey; R. F. Banziger; D. W. Blackburn; R. L. Bogner; C. J. Bryant; J. P. Buckley; J. A. Campbell; G. F. Collins; J. W. Dow; N. W. Dunham; H. C. Ferguson; C. M. Foltz; C. P. Headlee; H. H. Hutchins; E. E. Hamlow; M. W. Jordin; D. C. Kroeger; A. L. Picchioni; R. J. Schlembach; L. P. Sinotte; N. E. Webb; W. E. Wright.

LADIES ACTIVITIES -

Mrs. L. D. Edwards, Chairman; Mrs. J. E. Christian; Mrs. G. L. Jenkins.

ADDITIONS AND CORRECTIONS

Additions to the program

Dr. John E. Christian and associates gave the following additional demonstration.

1. Lauritsen Electroscope and Uses - E. F. Brake and C. J. Bryant
2. Determination of Half-life - P. F. Belcastro and M. W. Jordin.
3. Determination of the Energy of a Beta Particle (Feather Analysis) H. C. Ferguson and G. P. Lehrman.
4. Determination of Resolving Time - E. A. James and R. F. Banziger.
5. Phosphorus Distribution in the Tomato Plant - Ruth Kroeger and J. W. Dow.
6. Separation of Elements Using Ion Exchange in Combination With Radioactive Isotopes - D. C. Kroeger and N. W. Dunham.
7. Drug Distribution Studies - R. L. Bogner and A. L. Picchioni.
8. Calcium Depletion of Teeth - C. Urakami and C. M. Foltz.
9. Isotope Dilution Procedure Using Iron-59 - C. A. Bliss and T. S. Miya.

"The Screening Program in Industry" by Dr. K. K. Chen was supplemented by:

1. Cortisone-like Drugs and ACTH by R. C. Anderson.
2. Adrenergic Blocking Agents by Dr. F. G. Henderson.
3. Antihistaminics and Antispasmodics by Dr. H. M. Lee.
4. Analgesics by E. B. Robbins.

Changes in faculty

Dr. Carl A. Bundy, Director of Research, Pitman-Moore and Co., served in place of Dr. B. E. Abreu in the panel on "Graduate Instruction".

Dr. C. T. Ichniowski, Professor of Pharmacology, College of Pharmacy, University of Maryland, replaced Dr. Bratton in the general discussion of "Research Teamwork in Industry, in Colleges, and Cooperation Between Colleges and Industry".

Corrections in papers

Appendix B by H. G. O. Holck - Change the title by Oldham et al to read "second edition 1951".

In Appendix E by H. G. O. Holck - Change the word "prenic" to "phrenic".

REGISTRANTS AND PARTICIPANTS

Ahmed, Z. F., College of Pharmacy, Fouad 1st Univ., Cairo, Egypt
Alexander, Paul, Dept. of Education, Purdue Univ., Lafayette, Ind.
Anderson, R. C., Dept. of Pharmacology, Eli Lilly & Co., Indianapolis, Ind.
Andrews, F. N., Dept. of Animal Husbandry, Purdue Univ., Lafayette, Ind.
Arzoomanian, A. A., School of Pharmacy, Purdue Univ., Lafayette, Ind.
Bachmann, R. O., School of Pharmacy, Purdue Univ., Lafayette, Ind.
Bailey, H. S. Jr., School of Pharmacy, S. Dakota State College, Brookings
Bandelin, F. J., Flint, Eaton & Co., Decatur, Ill.
Banziger, R. F., School of Pharmacy, Purdue Univ., Lafayette, Ind.
Barker, D. Y., School of Pharmacy, Univ. of Manitoba, Winnipeg, Canada
Bastian, J. W., Dept. of Chemistry, Purdue Univ., Lafayette, Ind.
Baxter, R. M. & Mrs., Ontario College of Pharmacy, Toronto, Ont., Canada
Belcastro, P. F., School of Pharmacy, Purdue Univ., Lafayette, Ind.
Benson, W. M., Pharmacology Dept., Hoffman LaRoche, Inc., Nutley, N. J.
Bester, J. F., College of Pharmacy, Ohio State Univ., Columbus, Ohio
Bills, R. H., Pharmacology Dept., Eli Lilly & Co., Indianapolis, Ind.
Blackburn, D. W., School of Pharmacy, Purdue Univ., Lafayette, Ind.
Bliss, C. A., School of Pharmacy, Purdue Univ., Lafayette, Ind.
Bliven, C. W., School of Pharmacy, George Washington Univ., Washington, D.C.
Bogner, R. L., School of Pharmacy, Purdue Univ., Lafayette, Ind.
Brake, E. F., School of Pharmacy, Purdue Univ., Lafayette, Ind.
Bratton, A. C. Jr., Pharmacology Dept., Parke, Davis & Co., Detroit, Mich.
Brecht, E. A., School of Pharmacy, Univ. of N. Carolina, Chapel Hill, N.C.
Briggs, W. P., Am. Foundation for Pharmaceutical Education, New York, N. Y.
Brindamour, N. E. & Mrs., School of Pharmacy, Purdue Univ., Lafayette, Ind.
Brock, R. F., E. R. Squibb & Co., 2121 S. 9th St., Lafayette, Ind.
Brown, B. B., Pharmacology Dept., The Wm. S. Merrell Co., Cincinnati, Ohio
Brown, V. J., School of Pharmacy, Univ. of Oklahoma, Norman, Okla.
Buckley, J. P., School of Pharmacy, Purdue Univ., Lafayette, Ind.
Bryant, C. J., School of Pharmacy, Purdue Univ., Lafayette, Ind.
Byrum, W. R., School of Pharmacy, Univ. of Georgia, Athens, Ga.
Burt, J. B. & Mrs., College of Pharmacy, Univ. of Nebraska, Lincoln, Nebr.
Bunde, C. A., Research Director, Pitman Moore & Co., Indianapolis, Ind.
Campbell, D. E., Pharmacology Dept., Eli Lilly & Co., Indianapolis, Ind.
Campbell, J. A., School of Pharmacy, Purdue Univ., Lafayette, Ind.
Carroll, B. R., Student Health Div., Purdue Univ., Lafayette, Ind.
Chen, K. K., Pharmacology Dept., Eli Lilly & Co., Indianapolis, Ind.
Chew, W. B., Psychology Dept., Purdue Univ., Lafayette, Ind.
Christian, J. E. & Mrs., School of Pharmacy, Purdue Univ., Lafayette, Ind.
Clay, M. M., College of Pharmacy, Ohio State Univ., Columbus, Ohio
Coldiron, A. L., Aloe Scientific Co., St. Louis, Mo.
Collins, G. F., School of Pharmacy, Purdue Univ., Lafayette, Ind.
Conway, A. C., Lakeside Laboratories, Inc., Milwaukee, Wis.
Cook, J. R., Wyeth, Inc., 2711 Main St., Lafayette, Ind. (Wyeth Rep.)
Corley, R. C., Dept. of Chemistry, Purdue Univ., Lafayette, Ind.
Cwalina, G. E. & Mrs., School of Pharmacy, Purdue Univ., Lafayette, Ind.
Czerwinski, Mrs. A. L., College of Pharmacy, Creighton Univ., Omaha, Nebr.
Dandreau, J. L., College of Pharmacy, St. John's Univ., Brooklyn, N. Y.
Data, J. B. & Mrs., School of Pharmacy, Purdue Univ., Lafayette, Ind.
Davis, J. E., Pharmacology Dept., Univ. of Arkansas, Little Rock, Ark.
DeKay, H. G. & Mrs., School of Pharmacy, Purdue Univ., Lafayette, Ind.
Denison, E., Dept. of Biology, Purdue Univ., Lafayette, Ind.
Deno, R. A., Am. Council on Pharmaceutical Education, Chicago, Ill.
Dinwiddie, W. G., Pharmacology Dept., Eli Lilly & Co., Indianapolis, Ind.
Dow, J. W. & Mrs., School of Pharmacy, Purdue Univ., Lafayette, Ind.

REGISTRANTS AND PARTICIPANTS

Drommond, F. G., School of Pharmacy, Univ. of Colorado, Boulder, Colo.
DuBois, K. P., Pharmacology Dept., Univ. of Chicago, Chicago, Ill.
Dunham, N. W., School of Pharmacy, Purdue Univ., Lafayette, Ind.
Dunten, B. L., School of Pharmacy, Purdue Univ., Lafayette, Ind.
Edwards, L. D. & Mrs., School of Pharmacy, Purdue Univ., Lafayette, Ind.
Eisenbrandt, L. L., School of Pharmacy, Univ. of Kansas City, Kansas City,
Elliott, E. C., President Emeritus, Purdue Univ., Lafayette, Ind. Mo.
Ferguson, H. C., School of Pharmacy, Purdue Univ., Lafayette, Ind.
Foltz, C. M., School of Pharmacy, Purdue Univ., Lafayette, Ind.
Fonda, L. D. & Mrs., Brooklyn College of Pharmacy, Brooklyn, N. Y.
Francke, D. E., University Hospital, Univ. of Michigan, Ann Arbor, Mich.
Freije, W. E., School of Pharmacy, Purdue Univ., Lafayette, Ind.
Fugoso, J. B., School of Pharmacy, Univ. of Sto. Tomas, Philippine Islands
Gerding, P. W., School of Pharmacy, Purdue Univ., Lafayette, Ind.
Gilbert, M. W., Guild Instrument Co., Cincinnati, Ohio
Graham, B. E., Pharmacology Dept., The Upjohn Co., Kalamazoo, Mich.
Gross, E. G., Pharmacology Dept., State Univ. of Iowa, Iowa City, Ia.
Halsey, H. R., College of Pharmacy, Columbia Univ., New York, N. Y.
Hamlow, E. E., School of Pharmacy, Purdue Univ., Lafayette, Ind.
Hanmer, L. R., Albany College of Pharmacy, Union Univ., Albany, N. Y.
Harrisson, J. W. E., Phila. College of Pharmacy & Science, Phila., Pa.
Headlee, C. P., School of Pharmacy, Univ. of Oklahoma, Norman, Okla.
Heim, H. C., College of Pharmacy, Univ. of Colorado, Boulder, Colo.
Henderson, F. G., Pharmacology Dept., Eli Lilly & Co., Indianapolis, Ind.
Henning, C., School of Pharmacy, Purdue Univ., Lafayette, Ind.
Hibnick, H., Dept. of Chemistry, Purdue Univ., Lafayette, Ind.
Holck, H. G. O., College of Pharmacy, Univ. of Nebraska, Lincoln, Nebr.
Hutchins, H. H., School of Pharmacy, Purdue Univ., Lafayette, Ind.
Hutchings, L. M., Dept. of Vet. Sci., Purdue Univ., Lafayette, Ind.
Ichniowski, C. T., School of Pharmacy, Univ. of Maryland, Baltimore, Md.
Ireland, E. J., School of Pharmacy, Loyola Univ., New Orleans, La.
Iwamoto, H. K., School of Pharmacy, Univ. of Buffalo, Buffalo, N. Y.
James, E., School of Pharmacy, Purdue Univ., Lafayette, Ind.
Jenkins, G. L. & Mrs., School of Pharmacy, Purdue Univ., Lafayette, Ind.
Jones, G. T., Pharmacology Dept., Eli Lilly & Co., Indianapolis, Ind.
Jordin, M. W., Idaho State College, Pocatello, Idaho
Judis, J., Dept. Biol. Science, Purdue Univ., Lafayette, Ind.
Kaufmann, K. L., College of Pharmacy, Butler Univ., Indianapolis, Ind.
Keasling, H. H., College of Medicine, State U. of Iowa, Iowa City, Ia.
Kelleher, D., Purdue Univ. School of Pharmacy, Lafayette, Ind.
Kelly, C. J., College of Pharmacy, Xavier Univ., New Orleans, La.
Kluth, E. L., School of Pharmacy, Purdue Univ., Lafayette, Ind.
Koch, E., Wocher's Instrument Co., Cincinnati, Ohio
Kroeger, D. C., College of Pharmacy, University of Houston, Houston, Texas
Kroeger, R. M., College of Pharmacy, University of Houston, Houston, Texas
Lee, C. O. & Mrs., School of Pharmacy, Purdue Univ., Lafayette, Ind.
Lee, H. M., Pharmacology Dept., Eli Lilly & Co., Indianapolis, Ind.
Lehrman, G. P., School of Pharmacy, Purdue Univ., Lafayette, Ind.
Lesshafft, C. T., College of Pharmacy, Univ. of Kentucky, Louisville, Ky.
Leuallen, E. E., College of Pharmacy, Columbia Univ., New York, N. Y.
Levy, B., School of Pharmacy, Purdue Univ., Lafayette, Ind.
Lightstone, H., College of Pharmacy, Ohio State Univ., Columbus, Ohio
Livingston, A. E., School of Pharmacy, Temple Univ., Philadelphia, Pa.
Lucas, G. H. W., Univ. of Toronto, Toronto, Canada
McConnell, W. E., School of Pharmacy, Purdue Univ., Lafayette, Ind.
Mack, W. L., School of Pharmacy, Toledo Univ., Columbus, Ohio
Maher, F. T., School of Pharmacy, Univ. of Illinois, Chicago, Ill.

Mann, D. E. Jr., School of Pharmacy, Temple Univ., Philadelphia, Pa.
Marano, R. J. & Mrs., College of Pharmacy, Fordham Univ., New York, N. Y.
Marsh, D. F., Pharmacology Dept., W. Virginia Univ., Morgantown, W. Va.
Martin, R. J., Southern College of Pharmacy, Atlanta, Ga.
Meehan, Wm., School of Pharmacy, Purdue Univ., Lafayette, Ind.
Meyers, D. B., College of Pharmacy, Butler Univ., Indianapolis, Ind.
Miya, T. S. & Mrs., School of Pharmacy, Purdue Univ., Lafayette, Ind.
Morrison, R. W., School of Pharmacy, Univ. of S. Carolina, Columbia, S. C.
Muehlberger, C. W. & Mrs., Michigan Dept. of Health, East Lansing, Mich.
Mulvey, R. K., School of Pharmacy, Purdue Univ., Lafayette, Ind.
Murray, J. R., College of Pharmacy, Ohio State Univ., Columbus, Ohio
Nashed, W., School of Pharmacy, Purdue Univ., Lafayette, Ind.
Nelson, J. W. & Mrs., College of Pharmacy, Ohio State Univ., Columbus, Ohio
Niles, E. H., College of Pharmacy, Butler Univ., Indianapolis, Ind.
Norred, S. R., Howard College, Birmingham, Alabama
Patel, H. R., L. M. College of Pharmacy, Bombay, India
Picchioni, A. L., School of Pharmacy, Univ. of Arizona, Tucson, Ariz.
Pindell, M. H., Miles Laboratories, Elkhart, Ind.
Poland, L. O., Chemistry Dept., Butler Univ., Indianapolis, Ind.
Raabe, R. H., Pharmacy Dept., Ohio Northern Univ., Ada, Ohio
Ramstad, E. & Mrs., School of Pharmacy, Purdue Univ., Lafayette, Ind.
Reed, H. L., Massachusetts College of Pharmacy, Boston, Mass.
Reif, E. C., School of Pharmacy, Univ. of Pittsburgh, Pittsburgh, Pa.
Reitz, H. C., Chemistry Dept., Purdue Univ., Lafayette, Ind.
Rexrode, H. M., Phipps & Bird, Inc., Richmond, Va.
Robbins, E. B., Pharmacology Dept., Eli Lilly & Co., Indianapolis, Ind.
Rodman, M. J., College of Pharmacy, Rutgers Univ., Newark, N. J.
Roeder, H. M., Pharmacology Dept., Eli Lilly & Co., Indianapolis, Ind.
Rowe, E. J., College of Pharmacy, Butler Univ., Indianapolis, Ind.
Saute, R. E., School of Pharmacy, Purdue Univ., Lafayette, Ind.
Schaefer, H. H. & Mrs., Brooklyn College of Pharmacy, Brooklyn, N. Y.
Schlembach, R. J., School of Pharmacy, Purdue Univ., Lafayette, Ind.
Schuck, C., Dept. Foods & Nutrition, Purdue Univ., Lafayette, Ind.
Scott, P. M. & Mrs., School of Pharmacy, Wash. State College, Pullman, Wash
Sebastian, Y. F., Univ. of the Philippines, Manila, P. I.
Silirie, C. P., Medical Division, Merck & Co., Rahway, N. J.
Sinotte, L. P., School of Pharmacy, Purdue Univ., Lafayette, Ind.
Small, M. H., Pharmacology Dept., Eli Lilly & Co., Indianapolis, Ind.
Small, R. M., Pharmacology Dept., Eli Lilly & Co., Indianapolis, Ind.
Smith, C. R., School of Vet. Medicine, Ohio State Univ., Columbus, Ohio
Snyder, R. W., School of Pharmacy, Detroit Inst. of Tech., Detroit, Mich.
Sperandio, G. J. & Mrs., School of Pharmacy, Purdue Univ., Lafayette, Ind.
Stanko, G. L., School of Pharmacy, Purdue Univ., Lafayette, Ind.
Svedres, E. V., Schcol of Pharmacy, Purdue Univ., Lafayette, Ind.
Swanson, E., Pharmacology Dept., Eli Lilly & Co., Indianapolis, Ind.
Swinyard, E. V. & Mrs., College of Pharmacy, Univ. of Utah, Salt Lake City
Taylor, E. E., Student Health Div., Purdue Univ., Lafayette, Ind.
Thoms, R. K., Univ. of Connecticut, School of Pharmacy, New Haven, Conn.
Tsuji, F. I., School of Pharmacy, Duquesne Univ., Pittsburgh, Pa.
Tye, A., College of Pharmacy, Ohio State Univ., Columbus, Ohio
Uhl, A. H., School of Pharmacy, Univ. of Wisconsin, Madison, Wis.
Urakami, C., Osaka City Univ., Osaka, Japan
Vaiano, J. M., Hamilton Bell Co., Paterson, N. J.
Valley, G., Bristol Laboratories, Inc., Syracuse, N. Y.
Vander Brook, M. J., Pharmacology Dept., The Upjohn Co., Kalamazoo, Mich.
Vazakas, A. J., School of Pharmacy, Purdue Univ., Lafayette, Ind.

Vos, B. J., Div. Pharmacology, Food & Drug Administration, Washington, D. C.
Voss, E., College of Pharmacy, Univ. of Florida, Gainesville, Fla.
Walton, C. A., School of Pharmacy, Univ. of Kentucky, Louisville, Ky.
Ward, J. B., School of Pharmacy, Purdue Univ., Lafayette, Ind.
Warvel, J. H. Jr., Pharmacology Dept., Eli Lilly & Co., Indianapolis, Ind.
Waterman, F. A., Biology Dept., Wayne Univ., Detroit, Mich.
Watts, N. P., New England College of Pharmacy, Boston, Mass.
Way, E. L., Medical Center, Univ. of California, San Francisco, Calif.
Webb, N. E. & Mrs., School of Pharmacy, Purdue Univ., Lafayette, Ind.
Weeks, J. R., College of Pharmacy, Drake Univ., Des Moines, Iowa
Wenzel, D. G., School of Pharmacy, Univ. of Kansas, Lawrence, Kansas
Werner, H. W., The Wm. S. Merrell Co., Cincinnati, Ohio
Williams, B. B., School of Pharmacy, Alabama Polytech. Inst., Auburn, Ala.
Wilson, R. M., Ferris Institute, Big Rapids, Mich.
Wisler, G., Aloe Scientific Co., St. Louis, Mo.
Wolfe, N. & Mrs., School of Pharmacy, Purdue Univ., Lafayette, Ind.
Worth, H. M., Chemistry Dept., Eli Lilly & Co., Indianapolis, Ind.
Wright, W. E., School of Pharmacy, Purdue Univ., Lafayette, Ind.
Yakubik, J., School of Pharmacy, Purdue Univ., Lafayette, Ind.
Zapotocky, J., Pharmacy Dept., Duquesne Univ., Pittsburgh, Pa.
Zarrow, M. X., Biology Dept., Purdue Univ., Lafayette, Ind.
Zopf, L. & Mrs., School of Pharmacy, State Univ. of Iowa, Iowa City, Iowa
Zupko, A. G., St. Louis College of Pharmacy, St. Louis, Mo.

OBJECTIVES OF THE SEMINAR

by

Glenn L. Jenkins

Introduction

The Chairman of the Executive Committee, Dr. J. B. Burt, on November 24, 1950 informed the member colleges of the A.A.C.P. that the Executive Committee at its meeting November 13 and 14 had decided to hold a Seminar on Pharmacology and Related Subjects in the summer of 1951 and asked colleges to submit invitations. The Executive Committee expressed the opinion that a one week seminar in 1951 rather than a two week seminar as held in 1949 and 1950 might be advisable. Accordingly, Purdue University on December 5, 1950 extended an invitation for the A.A.C.P. to schedule the Seminar on Pharmacology here in 1951. This invitation was accepted, the week of July 9 was agreed upon, and the Seminar Committee consisting of Messrs. Burt, Chen, Edwards, Jenkins, Schaefer and Zopf met in the Pharmacy Building at Purdue University on March 17 to plan the seminar program. This brief resume is given to explain how the Seminar on Pharmacology came to be held at this time and place. It makes clear that the Seminar is held under the auspices of the American Association of Colleges of Pharmacy. Full credit is due the American Foundation for Pharmaceutical Education which granted funds to the A.A.C.P. to underwrite the expenses of the seminar. This grant of funds makes it possible to carry out our program without charging a fee to registrants. Purdue University has made its facilities available without charge except for living quarters and meals. Consequently, I believe that it is appropriate for me to speak in behalf of the A.A.C.P., the A.F.P.E. and Purdue University in welcoming you this morning.

I think you will agree that the Committee has constructed an extensive and instructive program. It was intended that this should be a working seminar. You will note that we have a full schedule. This schedule can be carried out most effectively if all in attendance will meet promptly and take their seats promptly after intermissions. A large number of demonstrations have been planned. It will assist the demonstrators if crowding is avoided and observers or participants gather in about equal groups about a single demonstration and systematically move from one demonstration to another.

Objectives

College and university teaching is now the subject of widespread discussion in state, regional and nation-wide conferences. Proceedings of these conferences such as "The Preparation of College Teachers" (Washington, D. C., The American Council on Education) and a new proceedings covering the December 1950 conference "Improving College Teaching" which will be issued are of special interest. "The Evaluation and Improvement of Instruction" (Stillwater, Okla., Agricultural and Mechanical College) gives an account of the plans used at the University of Missouri to enlist faculty participation in the program to improve instruction.

Many publications dealing with college teaching are available. In addition to numerous journal articles, the ground swell of interest in college teaching is currently bringing forth a number of significant books

and monographs only a few of which are mentioned here, namely:

(1) "The In-service Growth of College Teachers" Omaha, Nebr., Creighton University, 1950.

(2) "The Improvement of College Instruction Through In-service Techniques" (South Orange, N. J., Seaton Hall College).

(3) "Teaching by Discussion in the College Program," (Chicago, University of Chicago, 1950).

(4) "Effective Teaching" (New York, McGraw-Hill Book Co., 1950) is written from the viewpoint of engineering schools but contains suggestions of wide applicability.

(5) "Teaching in Colleges and Universities" (Indianapolis, The American Association of Dental Schools, 1945) interprets educational principles in terms of college teaching.

(6) "The Development of Professional Education" (Pittsburgh, Pa., The Carnegie Press, 1950).

(7) "Dynamics of Learning" (Buffalo, N. Y., Foster and Stewart, 1946).

(8) "This is Teaching" (New York, Harper & Bros., 1950).

(9) "College Teaching and College Learning" (New Haven, Yale University Press, 1949).

(10) "A Handbook for College Teachers" (Cambridge, Mass., Harvard University Press, 1950).

(11) "Goals for American Education" (New York, Harper & Bros., 1950).

(12) "Essays in Teaching" (New York, Harper & Bros., 1950).

These books and monographs can be read and studied with profit by college teachers in any area of instruction.

The Pharmaceutical Survey, the American Council on Pharmaceutical Education, the American Association of Colleges of Pharmacy, and other groups have taken actions and raised questions that demand an understanding and solution. All of these actions and questions are directed toward the same end, namely, the upgrading of pharmaceutical education. We cannot hope to find the answers to all of the problems at this seminar. In fact, it would not be rational for us to attempt to solve all of them, for it is our purpose to examine the status of pharmacology and related subjects as a single area in the curriculum and attempt to determine its proper place in the educational pattern of pharmacy schools. In this attempt it should be remembered that pharmacology is relatively a new subject in our curriculum; perhaps it would be better to say that it is an old subject that was scrambled into the composite stew known as materia medica.

The great upsurge in the importance of chemistry, biology and physics in the life of individuals and nations has brought about a new recognition of pharmacology. Some of our schools of pharmacy have observed the change and have established departments headed by competent specialists. Other schools have simply modified in varying degree the old materia medica

and monographs only a few of which are mentioned here, namely:

(1) "The In-Service Growth of College Teachers" (Iowa, Wm. C. Brown Co., Dubuque, 1949).

(2) "The Improvement of College Instruction Through In-service Training" (Santa Ana, Calif., Santa Ana College).

(3) "Teaching by Discussion in the College Program," (Chicago, The University of Chicago, 1950).

(4) "Effective Teaching" (New York, McGraw-Hill Book Co., 1950) is written from the viewpoint of engineering schools but contains suggestions of wide applicability.

(5) "Teaching in Colleges and Universities" (Indianapolis, The American Association of Dental Schools, 1945) interprets educational principles in terms of college teaching.

(6) "The Development of Professional Education" (Pittsburgh, Pa., The Carnegie Press, 1950).

(7) "Dynamics of Learning" (Buffalo, N. Y., Foster and Stewart, 1946).

(8) "Tools in Teaching" (New York, Harper & Bros., 1950).

(9) "College Teaching and College Learning" (New Haven, Yale University Press, 1949).

(10) "A Handbook for College Teachers" (Cambridge, Mass., Harvard University Press, 1950).

(11) "Goals for American Education" (New York, Harper & Bros., 1950).

(12) "Essays in Teaching" (New York, Harper & Bros., 1950).

These books and monographs can be read and studied with profit by college teachers in any area of instruction.

The Pharmaceutical Survey, the American Council on Pharmaceutical Education, the American Association of Colleges of Pharmacy, and other groups have taken actions and raised questions that demand an understanding and solution. All of these actions and questions are directed toward the same end, namely, the upgrading of pharmaceutical education. We cannot hope to find the answers to all of the problems at this seminar. In fact, it would not be rational for us to attempt to solve all of them, for it is our purpose to examine the status of pharmacology and related subjects as a single area in the curriculum and attempt to determine its proper place in the educational pattern of pharmacy schools. In this attempt it should be remembered that pharmacology is relatively a new subject in our curriculum; perhaps it would be better to say that it is an old subject that was assembled into the composite now known as materia medica.

The great upsurge in the importance of chemistry, biology and physics in the life of individuals and nations has brought about a new recognition of pharmacology. Some of our schools of pharmacy have observed the change and have established departments headed by competent specialists. Other schools have simply modified in varying degree the old materia medica

courses; and some schools have utilized the instruction available in schools of medicine. Is any single procedure the best or are all of them satisfactory?

During this seminar, in my opinion, we should seek to gain an understanding of the best procedure for instruction: (a) at the undergraduate level directed toward the education of competent pharmacists; (b) at the graduate level directed toward the preparation of specialists for teaching, research, and control. In trying to gain this understanding we should set our sights on the ideal program, realizing fully that this program will be modified and subjected to compromise as each school establishes its curriculum to fit the needs of its students and teaches according to the adequacy of its teachers and facilities.

The development of any program for evaluation requires that the legitimate interests should be considered of the following groups: (1) The recipient of the service resulting from the specialized education, i.e., the public; (2) the practitioner of the profession; (3) the teachers and administrative officers of the colleges; (4) the governmental licensing agencies.

The objectives of this Teachers Seminar on Pharmacology and Related Subjects may be stated as an attempt to answer the questions: What to teach? How to teach? This statement, of course, is obvious oversimplification.

The answer to the question "What to teach?" requires that we know the qualifications of those who are to be taught, their general educational background, the prerequisite courses they have had, the supporting correlated courses they take, and the educational objective of the student. The answer may be different in a well planned educational scheme as the student expects to enter a merchandising drug store, a hospital pharmacy, or take a job as sales representative or other position.

The answer to the question "How to teach?" involves the qualifications of instructor and student, the physical facilities and working conditions, the administrative policy and financial support. Should emphasis be given to coverage of the entire subject matter or to teaching general principles and illustrating them by examples? Is a textbook necessary or desirable? How well and how much can library assignments be used to advantage? Are demonstrations practicable? Can small recitation sections be used to advantage? How many students can one laboratory instructor properly supervise? Are group experiments desirable and practicable? What emphasis should be given to didactic and laboratory instruction respectively? To what extent can visual aids such as movies or slides be used to advantage? How can laboratory and didactic instruction best be correlated? How should examinations be constructed and evaluated? Other questions in great number such as how much to teach and when to teach various subjects might be raised.

In considering questions we should adopt an attitude of freedom to find the right answers irrespective of precedent or custom. Many of our procedures in education have been followed because the system of two or three lectures and one or two laboratory periods per week for science courses has been the custom.

Teachers, men of experience in the industry, and government workers have been included on the faculty to bring you the benefit of their experience. We cannot hope to solve all problems related to the area of instruction in pharmacology. If we can gain a better understanding from the precepts and demonstrations of the why, what and how to improve instruction this seminar will be well worthwhile.

THE NEED FOR A THOROUGH UNDERSTANDING OF PHARMACOLOGY IN PROFESSIONAL PHARMACY PRACTICE

Don E. Francke, Chief Pharmacist
University Hospital
University of Michigan
Ann Arbor, Michigan

I should like to preface my remarks on this topic with the opinion that the results of this Teachers Seminar on Pharmacology will have a great impact on the future of the profession of pharmacy and will profoundly affect the calibre and the stature of our future practicing pharmacists. During my several years of practice in pharmacy, I have had the opportunity on many occasions to discuss with other practicing pharmacists, the type of knowledge we find that we need in our everyday practice and wherein our training in pharmacy school fell short in supplying this need. A common denominator in all these discussions has been the general agreement that we in professional pharmacy practice need and want more thorough training in pharmacology and the closely related subject of biochemistry. We must have this training if we are to be full members of the public health team. Therefore I feel personally grateful to the American Association of Colleges of Pharmacy for sponsoring this Seminar, to the American Foundation for Pharmaceutical Education for supporting it, and to our hosts, the College of Pharmacy of Purdue University.

Pharmacology is important to pharmacists because it is the key link in the chain of knowledge between pharmacy and medicine. At present this link is weak; but this is only another way of saying that it can be, it should be, and I hope it will be, strengthened on the side of the practicing pharmacists. Advancement or progress in medicine and pharmacy is based primarily upon the application of and the extension of basic principles of pharmacology. To understand these new developments, the practicing pharmacist needs a thorough understanding of pharmacology. No better statement for the broad need for pharmacology by the practicing pharmacist - and particularly by the practicing pharmacist of the future - could be made than that which appears in The General Report of the Pharmaceutical Survey under the discussion of "Aims and Ideals".

"The pharmacist must be a professional man who understands thoroughly what he is doing, who comprehends the scientific bases of drugs and drug action, who is able to evaluate critically the products he handles, who is competent to advise physicians and members of the other health professions concerning drugs and their uses, who works at his profession creatively and advances its service.

Those who are concerned that pharmacy shall continue as a profession in fact recognize the changing character of much of the work of the pharmacist. They are thinking of how pharmaceutical service will be provided in the next quarter of a century when medical and other forms of health service will become more generally available than at present. Under the new arrangements for various types of medical centers and stations the pharmacist will play an increasingly important role. He will be thrown into intimate professional contact with members of the other health professions in ways that are now found chiefly in

hospital pharmacies.

They have also in mind the effect that mass production of medicinals is having on the character of the pharmacist's work. With the output of numerous products by the manufacturer it becomes increasingly difficult for the physician to keep up to date concerning available drugs and to weigh their merits against those of long-standing and established use. The logical person to whom the physician should be able to turn for scientific information is the pharmacist, who, being a specialist in drugs, should keep himself well informed concerning the merits of the various products. Obviously, if the pharmacist is to serve in this capacity, he will have to operate on a high professional level."

If we in pharmacy would increase our professional standing we must increase our training, particularly in areas which impinge upon and tend to bring us closer to the medical and allied health professions. No single revision of the Pharmacy Curriculum would help our profession more than would a general improvement in training in pharmacology. And of course, this implies or requires a good foundation in physiology and biochemistry, with some training in anatomy, histology and pathology. One of the current deficiencies which retards communication between pharmacists and physicians is the pharmacist's lack of an adequate vocabulary in pharmacology and medical sciences. Language is basic to communication. If the pharmacist is to comprehend what he reads in the medical literature, if he is to converse with physicians, he must have a thorough understanding of the technical terms in common use. A course in pharmacology could be so oriented as to supply this basic need to a great extent, or at least so as to give the pharmacist a firm foundation upon which to build.

This is an opportune time to strengthen our program in pharmacology because the teachers of pharmacology also appreciate more keenly than ever that they have a responsibility in training practitioners in the many specialties that contribute to the public health. At a conference on graduate education in pharmacology held at Yale in 1947, Dr. Maurice Seevers, then president of the American Society for Pharmacology and Experimental Therapeutics, when speaking of the steps those in pharmacology must take in the next few years, said, (We must) "Cooperate more actively as a Society and as individuals with other related scientific groups, such as industrial toxicology, dentistry, pharmacy, organic chemistry, veterinary medicine, public health and sanitation engineering, and those clinical branches of medicine which have to do with therapeutics."

To retain our perspective of the need for pharmacology it is well to pause and reflect that pharmacology is the youngest of the preclinical sciences. The first fulltime university professorship in pharmacology was not established until 1890 when Abel began his work at the University of Michigan. In fact, with but a few exceptions, the history of pharmacology in the United States up to 1935 is the story of the researches of Abel and his pupils. And let us not forget that the two most important factors in the early development of pharmacology was the rise of biochemistry which directed pharmacologic thinking toward cellular physiology and second, the development of pharmacology research laboratories by the pharmaceutical industry from which many of the basic advances in pure science have come. With these facts in mind, and, particularly

because of the very rapid advances in this specialty in the past few years and its obviously close relationship to all facets of the public health team, we can more readily appreciate that the time is ripe for pharmacy to utilize fully these developments.

Let us review briefly some of the areas in which the practicing pharmacist needs a thorough understanding of pharmacology. One of these is to serve as a consultant to the physician, nurse, dentist and veterinarian; on drugs; their properties, preparations, actions and uses, precautions in their use, dosage, side effects, toxicity, antidotes, absorption and excretion. In other words the practicing pharmacist should be able to readily supply the answers to questions of this type to the physician. The need for an unprejudiced source of information increases daily. The vast, ever enlarging, always changing field of therapeutic agents confronting the physician makes it imperative that he have assistance in finding his way through the labyrinth of complex and controversial materia medica. The introduction of a myriad of new synthetic drugs and the rapid advances in the field of antibiotics and hormones serve to emphasize the need of the pharmacist in the role of a consultant on drugs. The physician is so busily engaged in keeping abreast of developments in the fields of medicine and surgery that he has little time to devote to the study of new drugs.

It is not unrealistic or idealistic to say that physicians do ask pharmacists for this type of information. It is an everyday occurrence in the prescription stores and the hospital pharmacies throughout the country. The General Report of the Pharmaceutical Survey (page 196) summarizes the types of questions asked pharmacists by physicians. At least 25 percent of these require a knowledge of pharmacology to answer. I refer you to this Report for the list of specific questions asked the pharmacists. Some examples of the types of questions from physicians we encounter daily are: What is the best antidote for barbiturate poisoning? What new drugs are available for use in _____? Can digitoxin be injected intramuscularly or subcutaneously and, if not, why not? My patient is sensitive to Pontocaine - what other local anesthetic can be used in the eye? What oral analgesics with little sedative effect can I use for a patient with terminal carcinoma? Is there any danger of administering too much of a cationic exchange resin to a patient with edema? What sedatives, other than barbiturates, can I give to a patient with liver and kidney damage? What antitussive agents are available, other than codeine? Can sodium sulfadiazine be added to dextrose solutions for intravenous injection? Can streptomycin be given orally for a systemic infection? Is Chloroquine better than Atabrine for malaria? What is the antidote for atropine? Is lanatoside C a good cardiac drug for oral use? How does the new product containing racemic epinephrine compare with the U.S.P. product? What is the best preservative for eye solutions? What is the effect of Banthine on the urinary tract? What is the dose of Thyroxin for intravenous use? How do you calculate the dose for sodium lactate for acidosis? What is the procedure for testing sensitivity to Diodrast? What is a good low sodium urinary alkalinizing agent?

Practicing pharmacists in hospitals have some particular needs for a thorough understanding of pharmacology. And these needs are particular because of the functions and responsibilities which are specifically and definitely assigned to them and which they must undertake

as a part of their everyday work. Without elaboration, I shall mention the more important of these. An important one is the development of a hospital formulary working with the Pharmacy and Therapeutics Committee. I have here a few copies of formularies developed by hospital pharmacists and you may look them over if you care to. Another responsibility is the dissemination of information on new approved therapeutic agents as well as those in the investigational stage to the members of the hospital professional staffs. It is the pharmacist who must write this material and certainly a thorough understanding of pharmacology is priceless when he must make practical interpretations of pharmacological data. I have here some copies of the Bulletin of our Pharmacy and Therapeutics Committee which you may have. A third function is teaching pharmacology to nurses which is the responsibility of the pharmacist in a great many hospitals. Related to this is periodic reviews of new drugs for interns and graduate nurses. The hospital pharmacist is in a key position to advise medical interns on matters pertaining to drugs and to establish a thorough course in prescription writing. This is true since all graduates in medicine must serve an internship in a hospital and since all hospitals large enough to attract interns have a Pharmacy Department. This situation offers many potentialities with numerous ramifications which I shall not discuss at this time. Finally, and this may seem rather unusual, a knowledge of pharmacology is of considerable assistance in the economical purchasing of drugs in a hospital.

I would like also to point out that the medical service representative or detail man is, in effect, a consultant to the physician and a thorough understanding of pharmacology is invaluable to him. This is a specialized segment of pharmacy which offers many opportunities to our young graduates. A more thorough training in pharmacology would enhance the value of these individuals to the pharmaceutical industry and would assure the continuation of opportunities for pharmacists in this specialty.

It is obvious that we in practicing pharmacy have a great need for a better training in pharmacology. At present we suffer from rather severe handicaps in working with the medical and allied professions because our training has been inadequate to meet our needs. As new developments in medicine and pharmacy continue this need becomes increasingly greater as new types of compounds are introduced. The pharmacist is strong in his knowledge of the chemical structure and behavior of compounds and this helps him to interpret new drugs to the physician and to relate the similarities and differences in chemical structure and therapeutic action of drugs of the same group. But a better background in pharmacology would greatly enhance his usefulness as a member of the public health team. The team of the Pharmaceutical Survey has recognized this, for in its recommendations for changes in the pharmaceutical curriculum appear these words:

> "Qualifying students to cooperate with members of the other health professions and to consult with them; to furnish accurate, objective, and scientific information to physicians and members of other health professions concerning drugs and their action."

I cannot leave this phase of my topic without anticipating and answering an objection to teaching pharmacists more pharmacology which may come from our friends in the medical profession. Many of them may say that if we teach pharmacists more pharmacology that this will lead

to counter prescribing by pharmacists. I say that this is not true and in fact it would have an opposite effect. One does not find counter prescribing in the prescription stores nor in hospital pharmacies where we undoubtedly have some of our best trained pharmacists. And the reasons for this I believe are obvious. The more one becomes acquainted with the actions and uses of drugs the greater becomes his appreciation of the limitations of this knowledge. A thorough training leads to caution, teaches us to discriminate among values, and emphasizes to us that basic knowledge in pharmacology is one thing but that the application of this knowledge in the treatment of the patient is an art which involves the exercise of judgement, discrimination and a range of knowledge for which only the physician is trained.

Secondly, the practicing pharmacist needs a thorough understanding of pharmacology for rational compounding, dispensing, and product formulation.

In compounding, an understanding of pharmacology is needed in the preparation of many types of pharmaceuticals. In fact, the practicing pharmacist should know the ultimate use to which all preparations he makes will be put. This is compounding with intelligence. Some examples wherein a knowledge of pharmacology is essential include: The preparation of eye solutions which involve considerations such as the optimum pH for therapeutic action without appreciable loss of stability, the use of effective and nonirritating preservatives, and the adjustment of osmotic pressure; the preparation and sterilization of injectible medication for subcutaneous, intramuscular or intravenous use involves such considerations as choice of vehicle, duration of action, irritating properties of the vehicle and drug, toxicity and side effects of the medication, stability, and other factors related to the compounding of a safe and effective product; the use of alkalinizing agents in making suspensions of the sulfonamides; the choice of vehicles for all types of preparations; the compounding of ointments and ointment bases of various types; these are but a few examples wherein the practicing pharmacists need a knowledge of pharmacology. Blauch, writing in The General Report of the Pharmaceutical Survey (p. 109) summarizes the need by these words:

> "In the compounding of medicinal preparations a combined knowledge of chemistry, physiology, pharmacy, pharmacology, and related sciences is involved. This is true since in these procedures chemical substances are being prepared in a form suitable for use upon or in the human body."

In dispensing, the pharmacist must be alert and must utilize his knowledge of pharmacology if he is to play his part as a member of the public health team. Physicians are human and at times make errors in prescription writing, particularly when working under severe pressure. They should be able to look to us in pharmacy as coworkers on whom they can depend to intelligently analyze each prescription sent to us. Undoubtedly the largest area where we in pharmacy can use a knowledge of pharmacology in dispensing is in the matter of checking dosage. And of course we all realize that anyone can memorize dosages, but that is not the type of service I mean. We must have an appreciation of the significance of dosage if we are to perform our function well and for this we need a thorough understanding of pharmacology. It is only through

an appreciation of the significance of dosage and the effects of such dosage on the patient that we can be discriminating in our calls to the physician. Our training in pharmacology must be such that we can make relevant judgements based upon facts. In addition we must be able to discern when the physician has been thinking of one preparation but has prescribed another. An example of this would be a prescription for opium tincture for a child, when from the dosage it is obvious that the physician intended to prescribe paregoric. Often errors in directions to patient are encountered. These may be more surely noted by the pharmacist with a good background in pharmacology. Such factors as cumulative effects, antagonisms, synergisms, stability, precautions, and similar factors must all be kept in mind by the practicing pharmacist as he dispenses prescriptions.

The practicing pharmacist is sometimes required to do product formulation. Of course, this type of product formulation does not compare with that carried out in the pharmaceutical houses; but, nevertheless, such a request signifies there is a need at the time and this need must be met. In such instances a knowledge of pharmacology is of very great value. Examples of such product formulation that have arisen in practice include: a preparation of Chloromycetin for injection; a soluble form of tyrothricin; Benadryl eye drops, delayed action ACTH; buccal tablets of ACTH, protoveratrine, and atropine; cortisone eye ointments; and an isotonic solution of a nonelectrolyte, for which aminoacetic acid was employed, for use during transurethral resection operations.

A third need of pharmacology by the practicing pharmacist is to assume his role in public health education, particularly in the areas of prevention of disease and the rehabilitation of the handicapped. Public health education becomes increasingly more important all the time as the number of aged increases in our nation's population. A knowledge of pharmacology would give the pharmacist an appreciation of the significance of disease and, with his position in the community would make a valuable public relations contact between patient and physician. His role would be to encourage the patient to see his physician and to inform others of agencies available for rehabilitation. Perhaps this role of the pharmacist is somewhat in the future. But I believe there is definitely a place for it which we must plan for, prepare for and develop.

And last, but certainly not of least importance, I am convinced that a more thorough knowledge of pharmacology will so increase our professional background that the medical profession will develop a new concept of the pharmacist as a professional man. In today's world, the practicing professional pharmacist without a thorough understanding of pharmacology is an unfinished product. In your hands rests the ultimate status of our profession.

THE OBJECTIVES OF PHARMACOLOGY IN THE PHARMACY CURRICULUM

Frank T. Maher, University of Illinois

This title might aptly be re-phrased to read "Arguments for the inclusion of Pharmacology in the Pharmacy curriculum," since in discussing the objectives of this subject we are in reality establishing its importance in the training of the pharmacist. Instruction in Pharmacology is but a means of attaining a part of the objectives sought in the development of the total curriculum in Pharmacy.

Pharmaceutical education is based upon a realization that interest in drugs and medicines provides a common meeting ground for the health professions. Each of these brings to the patient a particular skill and knowledge, and depends in turn upon the contributions of the others in the total management of disease, as it is seen in man and in lower animals. These same factors offer firm support to interprofessional relations of trust and respect.

It is the particular province of the pharmacist to bring to this meeting ground a thorough knowledge of the properties of drugs. From this knowledge comes the formulation of pharmaceuticals suited to the demands of administration routes, disease types, and patient characteristics. Optimum therapeutic application is not achieved until such preparations are available, in adequate quantity and at reasonable cost, for each drug substance of basic worth. It is the further responsibility and privilege of the pharmacist to serve a liaison role between the doctor and the patient, to the best interests of each.

Major objectives in the training of pharmacists are met in the development of a broad familiarity with drugs and chemicals as physical and chemical entities. Pharmacology, and the sequence of courses in the biological sciences leading to it, are directed to an understanding of the biological response to drug substances, and to the applications of this basic phenomenon to the management of disease. Through proper integration within the pharmaceutical curriculum, we should see in the finished pharmacist a professional man familiar with the physical and chemical properties of drugs, and with applications of this information to the formulation of dosage forms. He further understands the principal problems of supply and manufacture, and is capable of assuming the responsibility for bringing to physical expression the quantitation of drug action expressed in the orders of the therapist. He recognizes the particular problems of the other members of the medical sciences, and the area of his own contribution to the common solution.

This broad integration of biological, physical, and chemical aspects in the study of drug agents renders unfortunate any tendency to confuse "pharmacology" with "pharmaco-dynamics"; that is, to concern ourselves solely with the actions of drugs as these are seen in the experimental animal. Drug action is not a phenomenon new to living function; the influence of a drug added to the environment of living cells and tissues is seen not in the development of a new function but rather in alterations of rate, direction, or end-point of functions already in progress. The influence of etiologic factors of disease is similarly brought to bear upon a pattern of established function, and it is this inter-relation

of physiologic function with the characteristics of drugs and of disease that establishes the rational basis of therapeutics. An important objective in the presentation of pharmacology is thus one of orientation in developing proper correlation between the basic phenomena of drug action and the application of that action to the therapeutic need.

The presentation of pharmacology is best made against a background of preparation in other areas of instruction within the pharmacy curriculum. Where these areas are not adequately developed, certain of the values must be included and correlated with the pharmacological presentation. It is generally true that the biological sequences of anatomy, histology, biochemistry, physiology, bacteriology, and pathology, as presented in the typical pharmacy curriculum, do not afford a satisfactory background for the full realization of the values looked for in the presentation of pharmacology. Current progress in the expansion of these biological sequences emphasizes the need for histologic appreciation, and for pathology, in future course developments.

Pathology and patho-physiology in particular are not commonly included in the pharmacy curriculum, and it is the province of the pharmacologist and the toxicologist to introduce these areas of knowledge to the problems of drug action. An important concept, too frequently ignored, is the full realization that drugs are administered to sick people or animals; that drug action in therapeutics is introduced into a pattern of abnormal, rather than normal physiology.

This is not to recommend that pharmacists be trained in the recognition of pathologic processes, or in the diagnosis of disease. It is rather a realization that drug action occurs in a dynamic environment; that the nature and degree of drug action may be and frequently are profoundly altered by environmental changes resulting from disease. The relative toxicity of morphine in the presence of lowered metabolic activity as seen in hypothyroidism is a case in point, and may be compared with the increased tolerance for opiates exhibited by individuals suffering severe pain. The importance of organ pathology to drugs metabolized or excreted by organs involved is a common problem in liver disease, in kidney disease, and in impaired function of skin and lungs. Just as inflammation is basic to pathology, so is it fundamental to the terminology of disease, and to the pharmacologic and toxicologic aspects of drug action. Pneumonia, for example, is of interest in this connection not as a diagnostic or therapeutic problem to the pharmacist, but rather as a condition in which drug action must be studied in the presence of pain, fever, pulmonary inflammation and congestion--oxygen as a drug under such conditions takes on dynamic aspects in the light of increased oxygen demand by tissues, and decreased gas exchange in the lungs.

One primary objective motivating the teaching of pharmacology to pharmacy students lies, therefore, in presenting an organized approach to the appreciation of drug substances and their position in the management of disease. Implied here is a broad concept of disease as a deviation from normal function in all forms of living matter. Implementing this objective with a general program valid for the individual case is, of course, difficult--the following outline represents an approach to the organization of pharmacological subject matter from the viewpoint

of the pharmacy curriculum.

An Outline: The Area of Pharmacology in Pharmacy

I. General Principles

A. Introductory: The General Place of Drugs in the Total Therapeutic Armamentarium.

1. The relation of drug agents to disease processes as factors inducing deviations in normal physiology.

B. Routes of Administration of Drugs.

1. Correlation of each with needs of the patient.
2. Pharmaceutical forms available or necessary.

C. Absorption as a Fundamental Phenomenon in Drug Therapy.

1. Relation to basic physiology of body tissues and fluids.
2. Mechanisms of absorption.
3. Sites of absorption.
   a. Implications to the formulation of pharmaceuticals.

D. Metabolism and Fate of Drug Agents.

1. Detoxication.
2. Excretion.
3. Storage.
4. Organs and functions involved.
   a. Significance of pathologic changes in organ function.
5. Implications to dosage schedules.
   a. Time factors.
   b. Blood levels and distribution.

II. The Principal Drug Groups.

A. General action of the group: position in therapy.

1. Review and correlation of underlying physiology.
2. Pathologic and pathophysiologic variations from basic function.
3. Site and mechanism of action: Type and nature of this action.
   a. Relation of activity to chemical structure.
   b. Relation of activity to physical properties.
   c. Significance of these factors to therapeutic application.
4. Advantages and disadvantages of the basic action type.
   a. Relation to other drug groups.

B. Modifications within the group.

1. Correlations with activity modifications.
2. Direction of research and development.

III. Consideration of the Individual Drugs

A. Individual properties, in relation to group.

B. Relation to other drugs of similar end-action, by other mechanisms.

C. Qualifications for therapeutic consideration.

D. Current status: Increasing, static, or decreasing phase of therapeutic interest.

E. General measures for recognition, prevention, or management of side-effects and toxic reactions.

F. Pharmaceutical preparations available.

IV. General Considerations of Drug Action.

A. Quantitative aspects.

1. Implications to dosage.
2. Relation to toxicology.

B. Activity relationships with other drug agents.

1. Additive effects.
2. Synergism.
3. Antagonism.
   a. Antidotal measures.
   b. Correction of side-effects.

C. Individual variation from general patterns of response.

1. Species variation.
   a. Significance to veterinary practice.
   b. Activity interpretations in terms of human response.
2. Tolerance: Natural, acquired.
3. Sensitivity.
4. Idiosyncrasy.

D. Correlation with therapeutic objectives.

1. Rational or empiric basis of therapy.
2. Symptomatic therapy.
3. Supportive or palliative therapy.
4. Replacement, or substitution therapy.
5. Definition or specific therapy.

E. Extension of drug action to toxic levels of intensity.

1. Estimation and prediction.
2. Symptoms and signs.
   a. Role of the pharmacist in recognition.
   Principles of corrective management.

V. Summary: Factors determining, for the Individual Problem:

A. Choice of drug, and logical alternates.

1. Nature of the disease present.
2. Patient characteristics.
3. Properties and actions of the drugs pertinent.

B. Route of administration.

C. Dosage form.

D. Dosage schedule.

E. Duration of therapy.

F. Precautions.

Factors listed in this section represent the chain of thought that culminates in the ultimate writing of the prescription or hospital order. From this point of view we may say that in medical practice, as in pharmacy, the objectives of pharmacology are directed to the proper formulation of drug therapy, in an atmosphere of professional understanding.

VI. Principal Features of Drug Traffic Control.

A. Integration with Jurisprudence.

B. Development and marketing of new drug agents.

C. Levels of legal restriction.

D. Advertising and Promotion.

E. Social Implications: Pharmacist-Public relationships.

VII. Collateral Areas of Course Development.

A. Sources of Information.

1. The library.
   a. Critical attitudes in reading.
2. The laboratory.
   a. Critical attitudes in the evaluation of data.
3. Commercial literature.
4. The lay press.

B. Projection to Future Activities.

1. The pharmacist's reference library.
2. Inter-professional service facilities.
3. Vocabulary development.
4. Estimation of future progress and changes.
   a. Acquisition, modification and deletion of information.
   b. Significance to student entering professional practice.
   c. Significance to graduate study in pharmacology.

C. Relation to developments in other fields of study.

The foregoing program of study is not offered as a teaching outline, nor does it indicate a chronologic order of presentation. It represents an attempt to integrate an area of knowledge with the general field of medical science. Local factors of space, staff, curriculum time, and facilities will, of course, influence the degree of accomplishment which may be anticipated. The approach should look to the realization of:

1. Professional pharmacists, equipped to maintain adequate drug supplies; to serve their professional associates in a common interest in drugs and medication; to safeguard the interests of the patient-customers who are the ultimate consumers of drug products, and the responsibility of the health sciences.

2. Students interested in graduate training, soundly grounded in basic principles of drug action, and stimulated to seek the further offerings of advanced course instruction and research techniques.

3. Students from other fields, prepared to integrate biological aspects of drug substances into the principal pattern of their thinking.

Broadening the understanding of the pharmacist in the role of drugs in therapeutics is not intended to stimulate the practice of counter-prescribing. Indeed, it would seem that a deeper appreciation of the position of pharmaceutical service in the health sciences may counteract this practice more effectively than any legislation or appeals to ethics.

The pharmacist is not, and should not be trained in the diagnosis and management of disease. He finds his professional pride in translating the needs of these areas into practical medication, and in serving as a professional consultant to the associated medical practitioners, in problems involving drugs.

Such a pharmacist does not see in a coughing patient a logical cough-syrup consumer; neither does he regard the cough as a disease to be eradicated by the pharmaco-dynamics of codeine. He does appreciate the value of the cough--to the patient as a defense mechanism; to the physician as a symptom and a guide-post to diagnosis.

These values are embodied in the total teaching objective of pharmaceutical education. They become the objective, the responsibility, indeed the <u>raison d'etre</u> of pharmacology in the pharmacy curriculum.

THE MINIMUM PREREQUISITES FOR THE UNDERGRADUATE PHARMACOLOGY COURSE

Leroy D. Edwards
Professor of Pharmacology, Purdue University, Lafayette, Indiana

This discussion of the prerequisites for the undergraduate pharmacology course in pharmacy schools comes at a very opportune time. Many schools of pharmacy are now in the process of setting up undergraduate courses in pharmacology or are revising existing courses and prerequisites.

Pharmacology is a synthetic science--many basic sciences are interwoven into the fabric termed pharmacology. Thus, the effect of drugs upon the functioning of fundamental chemical and physical phenomena, as are found in the living normal organism or tissue, constitutes a pharmacological reaction. Physiology must be placed in the same category since it is the study of the normal functioning of basic chemical and physical phenomena as are found in the living organism.

This means that students in order to gain a true understanding of pharmacology must enter the course well grounded in the physical, chemical and biological sciences. If this knowledge is lacking the best the student can achieve is the memorization of a multitude of statements. There can be little hope that he will ever be able to "think through" pharmacological problems. Such information is useless and, therefore, soon forgotten. Thus, it is evident that we must insist on certain minimum prerequisites in the chemical, physical and biological areas for entrance into the undergraduate pharmacology course.

The pharmacy curriculum as now presented includes many courses which contribute to a sound foundation for the study of pharmacology. This is true to the point that many are of the opinion that in the future true pharmacology will experience its fullest development in the field of pharmacy. Knowledge of the sources and physical properties of drugs is gained through such courses as general, qualitative, quantitative and pharmaceutical inorganic chemistry, general and medicinal organic chemistry, plant chemistry, biochemistry and pharmacognosy. The significance of dosage forms for various types of administration of drugs is well covered in the several pharmacy courses--physical, galenical, dispensing, hospital and manufacturing pharmacy. Further useful information is obtained in such required courses as general and pathogenic bacteriology, mathematics and physics. In addition to these required courses there are available in some pharmacy schools many elective courses which offer excellent foundation material for the study of pharmacology, i.e., physical chemistry (required in some of the better schools), statistics, isotope tracer techniques, endocrinology, glass blowing, experimental animal physiology, public health, industrial microbiology, etc. It is admitted that the present four-year course permits few of our undergraduates to take advantage of these elective disciplines. But it must be clear that even the present pharmacy curriculum abounds in material that is most useful to the study of pharmacology.

The greatest deficiencies as far as prerequisites are concerned is the lack of training in the biological field. It appears that pharma-

ceutical educators have been reluctant to include these courses in their curricula. Even today in some of our better schools of pharmacy we find substandard biological courses being offered such as physiology without laboratory training. A possible explanation for such deficiencies in a presentday curriculum is that there is insufficient time available for such work in the four-year course.

What courses in biology should the teacher of pharmacology require as prerequisites for entrance into the undergraduate course? The following prerequisites are recommended by The Pharmaceutical Survey Consultative Committee on Pharmacology and Related Sciences in the Pharmaceutical Curriculum (C. W. Chapman, L. D. Edwards, R. B. Smith, M. W. Green, and L. E. Blauch):

(1) GENERAL BIOLOGY, 8 semester hours--laboratory and didactic instruction in the principles of botany and zoology. General biology is universally accepted as a prerequisite for study in any of the life sciences; therefore, there is no need at this time to justify it as a prerequisite for pharmacology.

(2) VERTEBRATE ANATOMY AND HISTOLOGY, 4 semester hours--laboratory and didactic instruction in vertebrate anatomy and histology. This is a hybrid course and might well be replaced by standard courses in comparative anatomy and histology. The value of such courses to the pharmacy student is to supply a knowledge of the gross and microscopic structure of organs and tissues which is essential to an understanding of the functions of these structures and to appreciate the action of drugs on these same structures.

(3) PHYSIOLOGY, 6 semester hours--laboratory and didactic instruction in physiology. A full understanding of pharmacological principles can only be obtained where the student has a broad physiological background. This knowledge should include animal as well as human physiology. It has been pointed out by many that the above six semester hours is insufficient time to gain the objective desired by most teachers of pharmacology. Further, some pharmacy schools are of the opinion that physiology should be taught as a professional course in the school of pharmacy. The reason given is that a course in physiology as presented by Arts and Sciences schools often minimizes and even omits many topics considered of utmost importance in pharmacy and medicine. In any event, all teachers of pharmacology should require for entrance into their undergraduate courses the best obtainable training in physiology.

In addition to the above four prerequisite courses the Survey Committee suggested the election of pathology as an added foundation for the comprehension of pharmacological principles. This election would hardly be feasible in a four-year course, but should be possible if a longer course is adopted in the future. Pathology, obviously, offers much to the pharmacology student and to the practitioner of pharmacy.

Many will be quick to point out that most pharmacy curricula at present require general biology and physiology. This is true, and only serves to lighten our prerequisite problem.

The writer being a teacher of pharmacology is duty bound to bring up several other points concerning prerequisites. Each year some students desire to enter the undergraduate pharmacology course lacking the prerequisites as set forth in the university catalogue. Many and varied reasons are offered as to why such an exception should be made, but experience dictates that in no case is the waiver of the prerequisites justified. Also, if the student has taken the courses as outlined as prerequisite to pharmacology he will have satisfied at the same time the prerequisites of many other valuable elective courses.

From this review it is evident that pharmacy affords all the basic information prerequisite to a top flight course in pharmacology. For the moment, the minimum biological prerequisites for the undergraduate course in pharmacology should consist of standard university courses in general biology, comparative anatomy, histology and physiology.

CORRELATION OF THE BIOLOGICAL SCIENCES IN THE PHARMACY CURRICULUM

Richard A. Deno
Professor of Biological Sciences, Rutgers University College of Pharmacy and Director of Educational Relations, American Council on Pharmaceutical Education

In discussing the material to be presented in this paper, the Chairman of the Seminar asked me to describe conditions among the biological sciences as they exist today in the pharmacy curricula, to present some of the practical difficulties among the colleges, and to speak on certain needs in the biological field. The title may appear to be misleading, but eventually correlation will be discussed. I hope that the material presented before that time will not infringe too much on territory allotted to others. If it does, it will serve as a horrible example of what absence of correlation leads to.

The Sequence of Courses in Biology in Accredited Colleges of Pharmacy

Before describing the present situation in the colleges, I would like to outline the sequence of courses in biology as I believe they should exist in the current four-year curriculum. I am completely sympathetic with the ideas presented by Dr. Edwards for strengthening biology, but throughout this paper discussion centers around the four-year curriculum, because that is the curriculum of most of our colleges today.

Table one shows a realistic sequence of courses in biology, together with credit hours, and clock hours of lecture and of laboratory work.

	1st semester	2nd semester
1st year:	gen. biol. (4; 48-48)	gen. biol. (4; 48-48)
2nd year:	*pharmacog. (4; 48-48)	anatomy (4; 48-48)
3rd year:	physiology (4; 48-48)	microbiol. (5; 48-96)
	*first aid (1; 0-32)	
4th year:	*pharmacol. (3; 48-0)	pharmacol. (4; 48-48)
	*pub. health (2; 32-0)	

Table 1. Biology courses. See text for discussion.

Courses marked with an asterisk are considered to be professional ones; the others are courses in basic biology. An acceptable substitute for the year of general biology is a semester each of botany and zoology. The semester of anatomy and that of physiology may be satisfactorily combined as an integrated one year course in anatomy and physiology. The course in microbiology should cover both general and pathogenic phases of the subject. If pharmacognosy is presented from the modern revised point of view, it should be given during the second semester of the third year; anatomy and physiology can then be offered during the second year, and microbiology in the first semester of the junior year.

I have called this sequence realistic because it comprises a total of 832 clock hours, or 26% of the minimum requirement of 3200 hours;

CORRELATION OF THE BIOLOGICAL SCIENCES IN THE PHARMACY CURRICULUM

Richard A. Deno
Professor of Biological Sciences, Rutgers University College of Pharmacy and Director of Educational Relations, American Council on Pharmaceutical Education

In discussing the material to be presented in this paper, the Chairman of the Seminar asked me to describe condition among the biological sciences as they exist today in the pharmacy curricula, to present some of the practical difficulties among the colleges, and to speak on certain needs in the biological field. The title may appear to be misleading, but eventually correlation will be discussed. I hope that the material presented before that time will not infringe too much on territory allotted to others. If it does, it will serve as a horrible example of what absence of correlation leads to.

The Sequence of Courses in Biology in Accredited Colleges of Pharmacy

Before describing the present situation in the colleges, I would like to outline the sequence of courses in biology as I believe they should exist in the current four-year curriculum. I am completely sympathetic with the ideas presented by Dr. Edwards for strengthening biology, but throughout this paper discussion centers around the four-year curriculum, because that is the curriculum of most of our colleges today.

Table one shows a realistic sequence of courses in biology, together with credit hours, and clock hours of lecture and of laboratory work.

	1st semester	2nd semester
1st year:	gen. biol. (4; 48–48)	gen. biol. (4; 48–48)
2nd year:	*pharmacog. (4; 48–48)	anatomy (4; 48–48)
3rd year:	physiology (4; 48–48)	microbiol. (5; 48–96)
	*first aid (1; 0–32)	
4th year:	*pharmacol. (3; 48–0)	pharmacol. (4; 48–48)
	*pub. health (2; 32–0)	

Table 1. Biology courses. See text for discussion.

Courses marked with an asterisk are considered to be professional ones; the others are courses in basic biology. An acceptable substitute for the year of general biology is a semester each of botany and zoology. The semester of anatomy and that of physiology may be satisfactorily combined as an integrated one year course in anatomy and physiology. The course in microbiology should cover both general and pathogenic phases of the subject. If pharmacognosy is presented from the modern revised point of view, it should be given during the second semester of the third year; anatomy and physiology can then be offered during the second year, and microbiology in the first semester of the junior year.

I have called this sequence realistic because it comprises a total of 832 clock hours, or 26% of the minimum requirement of 3200 hours;

because it represents a logical sequence of courses culminating in pharmacology; and because the time allotted to each subject is sufficient to allow for a reasonably substantial course, which should in turn enable the next more difficult subject to be given at a level commensurate with the intricacies of the material to be presented.

There are a few colleges that now offer all of these courses, not necessarily in the sequence indicated. Most of the colleges omit one or more of them.

Table two shows the number of accredited colleges that require the basic courses in biology indicated.

	didactic and lab. instruction	didactic instruction alone	not required
gen. biol. or bot. and zool.	53	2	
bot. alone	12		1
zool. alone	3		
anatomy	8	1	62
anat. and physiol.--1 yr.	5		
physiology	44	18	4
microbiol.	67	3	1

Table 2. Basic courses. See text for discussion.

Of the 55 colleges requiring introductory general courses in both plant and animal biology, 40 give work in botany and in zoology separately, usually a semester of each. The other 15 require a course in general biology, usually for one year. Each of the nine colleges that requires anatomy also requires a course in physiology, usually for one semester.

In the 53 colleges that require physiology but no anatomy, some instruction in anatomy is given either in the introductory course in general biology or zoology, or in the course in physiology itself. It is, of course, impossible to teach physiology without at least a rudimentary knowledge of anatomy. Actually the physiology courses in these 53 colleges are elementary ones in anatomy and physiology, usually for one semester and about half anatomy, half physiology.

Neither table two nor the preceding discussion gives any clue to the quality of the instruction in the courses in basic biology. A conservative opinion is that it is satisfactory or good in a majority of the colleges. There are, of course, cases where botany or physiology

	didactic and lab. instruction	didactic instruction alone	not required
gen. biol. or biol. and zool.	53	7	
biol. alone	12		1
zool. alone	3		
anatomy	6	1	62
anat. and physiol.	5		
physiology	14	19	4
microbiol.	67	3	1

Table 2. Basic courses. See text for discussion.

Of the 53 colleges requiring introductory general courses in both plant and animal biology, 40 give work in botany and in zoology separately, usually a semester of each. The other 13 require a course in general biology, usually for one year. Each of the nine colleges that requires anatomy also requires a course in physiology, usually for one semester.

In the 53 colleges that require physiology but no anatomy, some instruction in anatomy is given either in the introductory course in general biology or zoology, or in the course in physiology itself. It is, of course, impossible to teach physiology without at least a rudimentary knowledge of anatomy. Actually the physiology courses in these 53 colleges are elementary ones in anatomy and physiology, usually for one semester and about half anatomy, half physiology.

Neither table two nor the preceding discussion gives any clue to the quality of the instruction in the courses in basic biology. A conservative opinion is that it is satisfactory or good in a majority of the colleges. There are, of course, cases where botany or physiology

or microbiology is poorly presented and where the standards of achievements are low. However, in the 71 accredited colleges of pharmacy, the basic biological sciences are taught as well or better than in colleges and universities in general. This does not mean that improvements cannot be made in the quality of these courses in a considerable number of colleges of pharmacy.

Notwithstanding at least average quality of instruction, in examining departments of pharmacology we frequently are told frankly that the pharmacy students are ill prepared for substantial instruction in general pharmacology; ill prepared in basic biology, not in basic chemistry. They do not know physiology, because a scanty course has been given and about half has, of necessity, been anatomy. Physiology has been handicapped because of no preparation in anatomy, and sometimes because the introductory course in animal biology was the traditional grasshopper-type zoology. If the beginning course deals chiefly with the details of starfishes and clams, there is no vertebrate anatomy or histology, and physiology is limited to two or three lectures a week, mostly hygiene, even though the courses may be well presented and well learned, the student is going to be sunk when he runs head-on into drugs acting upon the autonomic nervous system.

Before leaving the basic courses we should point out that even though far from adequate in number in many colleges, requirements in these courses are more substantial today than they were before the recent war. In 1937-1938 the writer (1) made a study of the basic biological sciences in colleges of pharmacy as a project of the Committee on Problems and Plans of the A.A.C.P. Without going into details, comparison of the 1938 data with those assembled this summer shows improvement. For example, in 1938, four per cent of the colleges required anatomy; today, 13 per cent require it. Some form of introductory course in animal biology preparatory to physiology was required in 46% of the colleges in 1938; today, 82% have such a requirement.

Table three shows the number of accredited colleges that require the professional courses in biology indicated.

	didactic and lab instruction	didactic instruction alone	laboratory instruction alone	not required
public health		29		42
first aid	29			42
pharmacognosy	65	4	2	
pharmacology	63	5		3
materia medica	1	2		68

Table 3. Professional courses. See text for discussion.

Public health and first aid are classified as professional courses by the American Council on Pharmaceutical Education. To some this may appear to be arbitrary, but there are valid reasons for it, and since the courses carry few credit hours, any argument concerning the classification is chiefly academic. They are useful courses when well-taught, but since neither is essential as a prerequisite to pharmacology, they are not of great importance in this discussion.

The other three courses are of considerable interest here, partly because of the confusion prevalent among deans, teachers and pharmacists on just what each is. I recall a prominent dean once asking me, "just what is biology?" It developed that biology to him meant elementary zoology. Before proceeding further, we may well ask, "just what is pharmacognosy; pharmacology; materia medica?" I am asking the questions, not answering them.

However, that you may know what is meant here by each of these designations, pharmacognosy refers to the traditional pharmacognosy in contrast to the modern approach represented in the newest American textbook on the subject. Please understand that the term is restricted to the traditional solely because a large majority of the accredited colleges teach only the traditional pharmacognosy today. I am wholly sympathetic, as is the American Council on Pharmaceutical Education, to a new scientifically sound approach to this or to any other subject in the pharmacy curriculum.

Pharmacology could be defined by most of you more precisely than by me. The definition in Cushny may be acceptable, "the study of the changes induced in living organisms by the administration in a state of minute subdivision of such substances as do not act merely as foods." Included are posology, the pathological and antidotal aspects of toxicology, and other closely related subject matter. But pharmacology to me does not include the pharmacognosy and pharmacy of serums and vaccines, glandular products, allergenic extracts, vitamins and prescription specialties. It does include the pharmacodynamics of some of these items, but when all phases of knowledge concerning them are to be wrapped up in one term, it appears that materia medica is elected.

At least two of the three accredited colleges that still retain the term materia medica actually teach more pharmacology than do many of the other colleges that have embraced the newer term, at least in their catalogues. This is believed to be a better batting average than is found in the 68 colleges which offer courses labelled pharmacology; therefore the three will be considered together with the 68 in the following discussion.

As far as the nature of the courses is concerned, it has already been indicated that pharmacognosy in most colleges is of the traditional type. It is doubtful if more than 10% offer a course designed along the lines outlined in Pratt and Youngken. Probably this percentage will increase; it is also probable that the approach will not be universally adopted because many administrators believe that pharmacognosy should be restricted to the traditional, and that material added or reclassified as in the modern approach belongs in other courses. It is my opinion, as a pharmacist and as a biologist, that the modern school of pharmacognosists has many cogent arguments that are sound, both scientifically and educationally.

On the other hand, as pharmacology is actually taught, it may include almost anything to be found listed in the curricula of the colleges of pharmacy, with the possible exception of epistemology. In May, Secretary Costello of the Council received a telegram asking, "Please wire collect Universities which have departments of pharmacology and whether they teach drug law." I thought that "they" referred to the uni-

versities that "teach drug law." However, to be sure concerning this and also about the department angle (many colleges offer pharmacology but are not organized into departments) Mr. Costello telephoned the sender. He was told that the information sought actually was whether the departments of pharmacology teach drug law.

There are courses in general pharmacology in colleges of pharmacy which include vertebrate anatomy with laboratory demonstrations, physiology, histology, glandular products, manufacturing and marketing of biologicals, commercial production of antibiotics, first-aid, and in addition, of course, some few which teach pharmacodynamics. This is one of the pharmaceutical variations of what is known as academic freedom. An attempt has been made to eliminate from table five, to follow, the various courses that do not in part at least approach general pharmacology.

Before going to table five showing more detailed data on pharmacology, for comparison and general information, comparable data are given for pharmacognosy. Table four shows the clock hours devoted to required courses in pharmacognosy in the 71 accredited colleges, and also in 25 of these 71 colleges that are judged to have a professional pharmacognosist in charge of the courses. The 25, of course, are also included in the 71 colleges.

A teacher has been judged to be a professional pharmacognosist if his graduate study, memberships in scientific societies, and research publications have been in this field; or if one or more of the preceding is or has been true, and the other criteria appear likely to be fulfilled. For example, a new Ph.D. with the major in pharmacognosy is classified as a professional pharmacognosist although he may have only one or two publications. It is recognized that judgment has been involved in classifying certain teachers as professional pharmacognosists and in not so classifying others.

Clock hours are given in table four because they are more informative than credit hours. (Twenty of the 71 accredited colleges operate on the quarter system. A considerable number give one hour credit for two hours of laboratory work. Others require three, or four or more hours of laboratory work per credit hour).

		mean	median	mode	range
71	lect.	80	80	96(20)	0 - 176
	lab.	85	96	96(24)	0 - 198
	total	165	176	192(13)	64 - 308
25	lect.	87	96	96(7)	0 - 176
	lab.	103	96	96(6)	0 - 198
	total	190	192	192(5)	80 - 308

Table 4. Clock hours, pharmacognosy; 71: all accredited colleges of pharmacy; 25: accredited colleges having a professional pharmacognosist. See text for discussion.

In most cases, the hours listed in table four are devoted to traditional pharmacognosy. Where possible, courses such as biological pro-

		mean	median	mode	range
71	Lect.	90	80	96(30)	0 - 176
	Lab.	85	96	96(24)	0 - 198
	total	165	176	192(13)	64 - 308
25	Lect.	87	96	96(7)	0 - 176
	Lab.	103	96	96(6)	0 - 198
	total	190	192	192(5)	80 - 308

Table 4. Clock hours, pharmacognosy; 71: all accredited colleges of pharmacy; 25: accredited colleges having a professional pharmacognosist.
See text for discussion.

ducts have not been included. Undoubtedly, there are instances where courses that include non-traditional matter have been included in making the tabulation.

In the 25 colleges judged to have one or more professional pharmacognosists, the quality of instruction is usually good. In an equal, or possibly greater number of other colleges, the course or courses in pharmacognosy are good or at least adequate. They are taught by men who might be termed semi-professionals or amateurs. I recognize that a professional pharmacognosist might not agree with this impression. However, it is not unusual to find a rather ordinary college giving excellent undergraduate courses in pharmacognosy. This may be due to the emphasis placed on this subject over the years, or in part to the rather prosaic and static nature of a strictly traditional course. This leaves around a third of the colleges in which instruction in this professional area is judged to be inferior. Here pharmacognosy is frequently taught by the last man to be added to the staff.

As would be expected, in the half dozen or so colleges where outstanding undergraduate courses are found, there are one or more well-qualified professional pharmacognosists, and in several a modest graduate program is being carried on. In spite of this, the number of professional pharmacognosists in training is not enough to provide for the needs of the colleges, let alone other needs, in the foreseeable future.

Note should be taken of the fact that the time devoted to pharmacognosy in the 25 colleges is higher than the average for all colleges of pharmacy. The difference does not appear to be great when the comparable figures in table four are noted; but the 25 are also included in the 71. If the 25 colleges are compared with the 46 which lack professional pharmacognosists, the former colleges are found to require about 30% more pharmacognosy than the latter.

In table five, data comparable to those of table four are given, but for pharmacology.

		mean	median	mode	range
71	lect.	98	96	96(19)	33 - 192
	lab.	71	64	96(23)	0 - 192
	total	169	160	192(17)	64 - 288
34	lect.	88	96	96(9)	33 - 192
	lab.	70	64	96(10)	0 - 144
	total	158	160	192(6)	64 - 240

Table 5. Clock hours, pharmacology; 71: all accredited colleges of pharmacy; 34: accredited colleges having a professional pharmacologist. See text for discussion.

Criteria for judging a professional pharmacologist are the same as those used for pharmacognosy: graduate study, memberships in specific professional societies, and publications. Fourteen of the colleges have their pharmacology taught in a medical school, either a four year (11 colleges) or a two year (three colleges) one. In every care, the teachers

who instruct pharmacy students were classified as professionals. In one or two cases there was doubt, but it appeared that the qualifications warranted a professional classification.

This leaves 20 professional pharmacologists who are teaching in colleges of pharmacy that do not (except in one case) use the pharmacology departments of medical schools for undergraduate instruction. There are only six of the 20 who qualify as professionals on all three criteria. It is interesting to note that five of the six are at colleges that are part of a university that has a medical school, although the pharmacy college (except in one case) does not use the medical school for undergraduate teaching. There is, however, an exchange at the graduate level and relations are cordial in most of these instances. The other 14 professional pharmacologists in colleges of pharmacy qualify under one or two of the criteria--several of them are promising young recent graduates. Perhaps three or four of the 14 should not be classified as professionals, but the total figure of 34 is not much out of the way. If an error has been made, it is probably on the generous side. Unquestionably, less than one-half of the colleges of pharmacy have the services of a professional pharmacologist for the undergraduate courses.

In some of the remaining 37 colleges, instruction in pharmacology is fair, but not in nearly so many as are adequately served by semi-professional or amateur pharmacognosists. The reasons for this are not hard to understand. The subject matter and the laboratory techniques in a dynamic and highly technical discipline such as pharmacology are not readily self-taught. In many colleges, little scientific pharmacology is given, even though courses designated pharmacology are offered and required and textbooks of pharmacology are used.

It is interesting to note that the 34 colleges with professional pharmacologists average slightly fewer hours in pharmacology than do all of the colleges considered as a group. The differences in the figures are insignificant. There is another and significant difference, however, that is not evident in the figures. In the 34 colleges, most of the pharmacology is scientific pharmacology; in the 37, much of it is materia medica. If the materia medica could be separated by some means from the pharmacology, I am convinced that the 34 colleges with professional pharmacologists would be found to be offering a much greater amount of pharmacology than are the others.

If my impressions are well-founded, then more than one-half of the colleges need a professional pharmacologist. Evidence from the latest reports of the Council on the accredited colleges supports this statement. No other professional area except pharmaceutical administration has been specified more frequently as needing personnel, equipment, laboratories, or general attention.

However, the situation is better today than it was in 1937 when Dille (2) made a study of the teaching of pharmacology in colleges of pharmacy, as a project of the Problems and Plans Committee of the A.A.C.P. There does not appear today to be as much frank opposition to instruction in general pharmacology, especially laboratory instruction, and a greater number of full-time professional pharmacologists are teaching the course to pharmacy students.

The foregoing presentation of the sequence of courses in biology in colleges of pharmacy has been limited to undergraduate instruction in required courses. Before going to the second part of this paper, I would like to mention briefly the status of biochemistry in the four-year curriculum. To me, this subject is definitely prerequisite to pharmacology, as it is to microbiology. It should be required during the first term of the third year, at least a five semester hour course with a minimum of 48 hours didactic instruction and 96 hours of laboratory work. It should be of such content and grade as is characteristic of biochemistry in a good medical school, although the scope will have to be somewhat restricted to a five-hour course.

At present, 36 colleges do not require courses in biochemistry. Of the 35 which do, 29 give laboratory instruction and six have lectures only. In a considerable number, especially those with laboratory, very creditable courses are presented.

Correlations Among the Courses in the Sequence in Biology

The preceding material has doubtless been sufficiently confusing to you to bring home the point that biology courses now required in colleges of pharmacy are not uniform in number, content, credit hours, or quality. At the beginning I mentioned briefly the courses that I considered essential and practicable to require in the prevailing four-year curriculum. I also indicated the sequence that they should be given in, with certain possibilities for variation. The first one-year course, general biology, and the last, pharmacology, should not be changed. Otherwise some rearrangements are acceptable. However, anatomy should precede physiology; biochemistry should precede microbiology, and microbiology should precede pharmacology.

This logical sequential relationship is one aspect of correlation, the first step in logical correlation of these interrelated subjects. One of the miscellaneous bits of information that I have acquired during the past year is that this is technically termed "vertical correlation" by one of the leading departments of education. Effective vertical correlation, however, involves much more than merely having the proper prerequisites on paper. It is equally important or more so to know that the basic biology and chemistry has been adequately presented.

For example, in pharmacology a teacher has occasion to refer repeatedly to steroids of biological and pharmacological significance. In pharmacognosy and in organic, pharmaceutical, or biochemistry the biological and chemical classification of steroids should have been covered, and their general chemistry discussed. Perhaps this has been presented, perhaps not. Unless the pharmacologist knows in some detail how thoroughly steroids are covered in the earlier courses, he is likely to assume a background that the student does not possess.

Or the reverse may occur. The pharmacologist may assume (not without justification) that the student knows nothing about steroids. If the teacher happens to be interested in them, he may feel called upon to spend a few hours on a non-pharmacological discussion of steroids, duplicating much that may have been adequately covered elsewhere. Five or ten minutes of review would have been sufficient for his purpose.

A pharmacologist in a leading college of pharmacy recently told of an experience he had had in a lecture preparatory to one dealing with antimalarials. The preparatory lecture in the pharmacology course dealt with the life cycle of anopheline mosquitoes. Midway in his presentation he sensed a general boredom in the class, but continued until the end of the period. He later sought out a member of the class, to inquire about the reaction he had observed. He was told that this was actually the fourth time the class had been conducted personally on a round trip through the blood stream of a malaria patient and the salivary glands of an anopheline mosquito: first in general biology; later in microbiology; more recently in public health; and finally in pharmacology. Small wonder that the boredom was so acute as to be patently obvious. (This example has been used elsewhere (3) and it is hoped that those who heard it previously will forgive the duplication).

To return for a moment to the steroids, a specific example illustrating the need for correlation may be found in Cortisone. In biology, anatomy, physiology, and biochemistry should have been presented the basic concepts of the endocrine system. These involve an understanding of the metabolic relationships among the hormones, and the position of the pituitary as the "keystone in the endocrine arch."

Among the pituitary secretions, adrenocorticotropic hormone should have been discussed, and from the cortex of the adrenal gland, the adrenal cortical hormones; and, of course, the role of ACTH in stimulating secretion of ACH.

In pharmacognosy, the student should become familiar with medically important members of the strophanthus family, and should be acquainted with the fact that seeds from species of this family yield microscopic amounts of a steroid chemically related to Cortisone. This steroid is a link in the chain which ends in the synthesis of Cortisone. He should also learn here that seeds of certain members of the agave, amaryllis, yam, and yucca families are likewise found to contain traces of the precursor.

He might well be told of the search conducted during the past year under the direction of Dr. Donovan Correll of the United States Department of Agriculture to find a botanical source yielding significant amounts of a chemical precursor for Cortisone. Experts from the Department of Agriculture have searched in the Southwest, in Mexico, and in South America for a good natural source of starting material. This expedition had the same objective as that previously carried out in Africa, where species of Strophanthus were collected and later analyzed with disappointing results.

Meanwhile, in organic chemistry the steroids should have received attention. Discussions should include the nuclear structure common to the group; variations in this structure achieved by stereoisomerism, by oxidation or reduction, and by addition of various substituent groups; classification on a chemical basis; and brief indication of the biological significance of this important group of organic compounds. In organic chemistry would also be presented the significant achievement recently announced by Professor Robert B. Woodward of Harvard University. He has succeeded for the first time in chemical history in synthesizing a steroid from ortho-toluidine as the principal raw material. The biological phase in the story on steroids should be pursued further in biochemistry.

In the study of the chemistry of organic medicinals, the steroids of therapeutic importance should receive attention from the point of view of pharmaceutical chemistry.

Finally, in pharmacology should be presented the pharmacodynamic, toxicological and therapeutic aspects of medically important steroids, including Cortisone. The dramatic results achieved in the treatment of rheumatic fever, arthritis, and allergic conditions would surely be presented here.

To dispensing pharmacy should be left discussions relating to forms of medication.

It would be useful in merchandising to present the matter of excessive cost and the reasons for it.

This sketchy presentation of the treatment in the pharmacy curriculum of a single drug, Cortisone, illustrates the need for careful correlation of the elements presented in general biology, anatomy, physiology, biochemistry, pharmacognosy, organic chemistry, chemistry of organic medicinals, pharmacology, dispensing pharmacy, and merchandising.

Without this correlation, there is abundant opportunity first, for much needless duplication and waste of time, and second, for omission of one or more important links in the chain which constitutes the complete story.

We have spoken of what is sometimes termed vertical correlation, that essentially inherent in the idea of prerequisite courses, properly planned. A second type relates to courses given at the same time and dealing with some of the same subject matter but from different points of view. For pharmacology teachers, the two courses most likely to require this type of correlation with pharmacology are dispensing pharmacy, and the pharmacy and chemistry of organic medicinals. If you are interested in the educational gobbledygook for such correlation, it is "horizontal correlation" or simply "integration." (You are not supposed to integrate material presented in sequence; you correlate that vertically).

Just as I believe pharmacology should be the final course in the biology sequence, I believe that organic medicinals should cap the chemistry sequence, and dispensing that in pharmacy. In the three fields, these three courses respectively require the most in preparatory work and should represent the climactic courses. It may appear that a great deal of horizontal correlation among them is not required, but pharmacologists might be surprised to find how much alleged pharmacology is presented in many courses in dispensing pharmacy. Likewise, pharmaceutical chemists might hear some interesting chemical concepts by listening to certain lectures in pharmacology. There definitely is need for correlation of many specific topics among dispensing pharmacy, organic medicinals and pharmacology.

Conclusions

Among the conclusions that may be drawn from the preceding discussion are:

1. Most of the accredited colleges need to strengthen their require-

ments in basic science before an acceptable course in pharmacology can be given. In particular the general biology- or zoology-anatomy-physiology sequence is weak in a large majority of the colleges. In over half, no biochemistry is required. Reasonably adequate provisions can be made in a four-year curriculum providing about one-fourth of the total clock hours are given to the basic and professional courses in the biological sciences. This allotment is neither unreasonable nor unrealistic.

2. In nearly every accredited college, some rearrangement of the courses in biology is indicated. This is the simplest part of and actually a preliminary step toward correlation of these closely related courses. The chaotic order in which related courses are frequently given is due to the Topsy-like development of the curriculum over the years, plus a widespread lack of understanding of the organic connections among the several courses which logically lead to pharmacology.

3. In addition to "vertical correlations" on paper, achieved by careful observation of prerequisite requirements, there is need for systematic efforts to insure that basic courses are basic to pharmacology in <u>fact</u> as well as in <u>theory</u>. This is not easily done, especially in university colleges where basic courses are given outside the college of pharmacy. However, it has been done, and usually teachers of basic subjects welcome inquiries and suggestions from those who give the professional courses. The chief objective of "vertical correlation" is to insure the inclusion of subject matter essential to teaching and learning in an advanced course, but properly belonging in a more elementary one. It should also result in avoidance of needless duplication.

4. Correlations among related professional courses whose subject matter is on a level in the curriculum, "horizontal correlations,"can be achieved by discussion among the teachers involved. It is not inconsistent with the principles of academic freedom to cooperate with others who treat parts of your subject matter from a different point of view. This type of cooperation is especially important as the colleges abandon the outmoded "official pharmacy-materia medica" approach to the teaching of professional subjects. The objectives here are identical with those of "vertical correlation," with perhaps greater emphasis on the avoidance of needless duplication.

5. More than one-half of the colleges of pharmacy do not have available the services of a professional pharmacologist. Lack of financial support cannot be invariably blamed. Isolated location, absence of scientists in related fields, and a shortage of well-trained professional pharmacologists are also contributing factors. Relief will be hastened if capable students in larger numbers are encouraged to enter this field, and if more colleges make provisions whereby junior staff members interested in pharmacology are enabled to complete graduate studies.

6. The responsibilities of the qualified pharmacologists now teaching pharmacy students need to be emphasized. In a college there is slight chance for marked improvement in the conditions just outlined when the pharmacologist:

a. Gives a substandard course in general pharmacology or devotes half his time to presentation of basic anatomy and physiology rather than earnestly campaigns for adequate prerequisites.

b. Makes no attempt to work with his associates in basic biology or in related professional areas of instruction in pharmacy in order to so correlate the treatment of the same subject matter, presented from different points of view, that the essential basic and professional material is well-covered without needless and dulling repetition.

c. Refuses to assume the responsibility of acting as a self-appointed sergeant to swell the overly-thin ranks of professional pharmacology.

These comments are intended solely as a reminder that the colleges need help from you, in order that the biological sciences in the pharmacy curriculum may eventually become as strong as the chemical ones, and in order that pharmacology may be presented in all the colleges to adequately prepared students and by qualified professional pharmacologists.

References

(1) Deno, R. A., Am. J. Pharm. Educ., 3, 5 (1939).

(2) Dille, J. M., ibid., 2, 8 (1938).

(3) Deno, R. A., Proc., Dist. 7 N.A.B.P.-A.A.C.P. (1951)

THE UNDERGRADUATE COURSE IN PHARMACOLOGY--DIDACTIC

Harald G. O. Holck
University of Nebraska, College of Pharmacy

Introduction

In considering the teaching of pharmacology in schools of pharmacy it seems pertinent to point out certain differences between the objectives and content of the course for pharmacy students and those of the course offered in schools of medicine. These differences are:

A. In the medical course more stress can be placed on that member of a group of therapeutic agents closest to the ideal as a typical example, and upon the latest developments in that area, while in the pharmacy course we must attempt to acquaint the student not only with these two phases, but with a much larger number of drugs. This is because the pharmacist will handle not only prescriptions from medical practitioners and specialists in medicine, but also those from the dental and veterinary professions. Moreover, he must deal with prescriptions from older practitioners who have graduated a number of years ago, so that prescriptions for older drugs will come to him in considerable numbers.

B. Secondly, the pharmacology instructor in the pharmacy school is favored by the fact that the pharmacy student comes to him in the junior or senior year with considerably more information as to names, appearance, source, manufacture, physical and chemical properties, dosage, prescription writing, and other information concerning drugs than is the case of the medical student. The latter's information is largely limited to that gleaned from his course in physiology and biochemistry. On the other hand, the medical student is better versed in the preclinical sciences.

To plan the teaching of pharmacology it also seems imperative that the teacher examine in outline form all the elements of information about a given drug or group of drugs for the purpose of selecting those parts which are essential to a course in pharmacology for pharmacy students. For the purpose of such an examination, we have made such an outline which you will find under Appendix A.

The fact that the maximum time devoted to lectures in pharmacology probably will be three hours a week for the school year, supplemented by a weekly laboratory period of three hours, has an important bearing upon the use of this chart. Not only must the number of therapeutic agents and of poisons be limited in number, but in most cases time will not allow one to more than bring out the major factors, primarily as related to man.

In view of the apparently ever-increasing number of new medicaments and of other substances, such as solvents, rodenticides, insecticides and herbicides, with toxic capabilities, such selection poses serious problems. Furthermore, recent advances in pharmacology and

THE UNDERGRADUATE COURSE IN PHARMACOLOGY--DESIRED

Gerald G. O. Holck
University of Nebraska, College of Pharmacy

Introduction

In considering the teaching of pharmacology in schools of pharmacy it seems pertinent to point out certain differences between the objectives and content of the course for pharmacy students and those of the course offered in schools of medicine. These differences are

1. In the medical course more stress can be placed on that number of a group of therapeutic agents closest to the ideal as a typical example, and upon the latest developments in that area, while in the pharmacy course we must attempt to acquaint the student not only with those two phases, but with a much larger number of drugs. This is because the pharmacist will handle not only prescriptions from medical practitioners and specialists in medicine, but also those from the dental and veterinary professions. Moreover, he must deal with prescriptions from older practitioners who have graduated a number of years ago, so that prescriptions for older drugs will come to him in considerable numbers.

2. Secondly, the pharmacology instructor in the pharmacy school is favored by the fact that the pharmacy student comes to him in the junior or senior year with considerably more information on to means, appearance, source, manufacture, physical and chemical properties, doses, prescription writing, and other information concerning drugs than is the case of the medical student. The latter's information is largely limited to that gleaned from his course in physiology and biochemistry. On the other hand, the medical student is better versed in the preclinical sciences.

3. To plan the teaching of pharmacology it also seems imperative that the teacher examine in outline form all the elements of information about a given drug or group of drugs for the purpose of selecting those parts which are essential to a course in pharmacology for pharmacy students. For the purpose of such an examination, we have made such an outline which you will find under Appendix A.

4. The fact that the maximum time devoted to lectures in pharmacology probably will be three hours a week for the school year, supplemented by a weekly laboratory period of three hours, has an important bearing upon the use of this chart. Not only must the number of therapeutic agents and of poisons be limited in number, but in most cases time will not allow one to more than bring out the major factors, primarily as related to man.

5. In view of the apparently ever-increasing number of new medicaments and of other substances, such as solvents, rodenticides, insecticides and herbicides, with toxic capabilities, each selection poses serious problems. Furthermore, recent advances in pharmacology and

associated fields greatly increase the difficulties of arriving at an adequate solution of this problem. This includes such aspects as changing conceptions of modes of action, clearer understanding of physiological functions and new ideas resulting from studies upon the cells of the body and from investigations involving the use of isotopes. Moreover, the organization of the course is all the more difficult because in most cases pharmacology instructors in the pharmacy schools usually have but a very limited direct contact with the actual employment of drugs in hospitals or clinics or by the practitioner. Consequently, he must in a large measure obtain his information second hand.

The Textbook in Pharmacology as a Source of Information

The textbooks in pharmacology constitute a major source of such information. However, the novice will soon discover that he is unlikely to find all the information he wants in any single text. Writers of texts in our fields are individualists. They have their own ideas as to how the subject matter is best organized and presented. They are exposed to a maelstrom of pressures to include all of the newest remedies; they also are faced with the problem of what is profitably condensed or deleted; likewise, they must determine the amount of toxicology to include. Thus, from edition to edition they must carefully attempt to evaluate these and other aspects. Finally, they must also consider the wishes of their publishers, lest the book becomes so encyclopedic or so limited in scope that it is not readily marketable.

Arrangement of Topics and Amounts of Review Material. An examination of a number of texts, some in great detail, reveals that the individuality of each author is shown in numerous ways. His personality is first of all brought out in his arrangement of the various topics. Thus, to illustrate such divergence, the initial topic of the material, after varying degrees of emphasis on introductory matters, may be the general anesthetics, the stimulants of the central nervous system, the vitamins, the general antiseptics, or the locally acting drugs. Authors also vary considerably in the amount of review material from associated fields of knowledge they consider it desirable to present to the student, as, for example, the physiology of the heart and circulation and their deficiencies or discussions dealing with the autonomic nervous system. Such reviews are indeed valuable to the reader, but they do take up space.

Divergence in Coverage and Classification. There is wide divergence among textbooks in pharmacology in the number of drugs and poisons included, and in the amount of space allotted to historical aspects and comparative pharmacology. A detailed examination of several recent textbooks revealed fairly close agreement in the relative emphasis placed upon a number of major topics, although two of these omitted any reference to poisonings due to lead, phosphorus, carbon monoxide and cyanides and a third discussed only lead poisoning in any detail. These latter texts are devoted primarily to the evaluation of therapeutic agents. Likewise, wide differences were found among textbooks in the matter of inclusion or exclusion of a considerable number of minor drugs.

Some of the variation found is probably due to the fact that each author may be more expansive when discussing fields within which his own research activities fall. Even greater complexity arises from the fact that one and the same agent may be placed in different categories by

different writers. Is it preferable to list all the actions of a drug under the heading of such a substance so as to give the student a comprehensive understanding of its varied actions, as in case of caffeine? Or, is it better to discuss it under separate functional or therapeutic headings. In the latter case, the actions of caffeine would then be described in part under the central nervous system stimulants, in part under circulatory modifiers and in part under diuretics. It may be still more advantageous to effect a compromise by discussing caffeine under the main heading of xanthines, with emphasis on the cerebral action and referring to proper pages for details of the other actions under their respective groups.

Inclusion of Special Topics. Inasmuch as toxicology constitutes an important phase of instruction in the pharmacy schools, it is of interest to note that a resume of the principles of toxicology is presented in some texts, though in many such a digest is absent. In view of progressive emphasis on proper evaluation of experimental data and of more detailed information on the pharmacology of the cell, it is but natural that texts differ considerably in the stress they place upon these phases. Since bioassay is included in our curriculum, it seems a definite advantage to me to incorporate concise discussions of the most fundamental aspects of statistical conceptions relating to that field which will develop the ability of the student to determine when a new remedy is superior to an old one. This treatment should not be more complex than the student with only college algebra and trigonometry can readily comprehend.

Factors in Selecting a Textbook of Pharmacology. In selecting a textbook of pharmacology, the major factors to consider seem to be: (1) Completeness of coverage of the essential subject matter of interest to the pharmacy student; (2) Arrangement of material; (3) Style, readability and freshness of approach; (4) Parallelism with current developments in the field of pharmacological science; (5) Point of view of the author, especially with reference to whether the book has been written primarily for students of medicine, or is well adapted to the use of students of the other health sciences; and (6) Its size when considered in relation to the number of hours allotted to the course.

We are presenting in Appendix B what we believe to be a reasonably complete list of textbooks of pharmacology (and related subjects) written in English for the medical and allied health professions.

Comparison with Teaching of Pharmacology in Denmark. To indicate the trends in the teaching of pharmacology and biological assay in other countries, we have brought with us a set of lecture notes in pharmacology (exclusive of hormones and vitamins) issued in 1950 by several students of the College of Pharmacy of Denmark (Denmarks Farmaceutiske Højskole) and used in the 50-hour course, and a set of notes dealing with bioassay, which shows that a relatively greater emphasis is placed on this subject than in this country. This school offers in addition to the latter course, a two-and-one-half year course to those wishing to specialize in biological testing.

Additional Sources of Information in Pharmacology

In addition to the texts, numerous up-to-date reviews on pharmacological topics by specialists in their field are valuable in keeping

the teacher well informed. The importance of such reviews in a field of tremendous flux is emphasized by the fact that the American Society of Pharmacology and Experimental Therapeutics in 1949 sponsored a new publication, Pharmacological Reviews. The much older Physiological Reviews contains pharmacological subjects to an extent of about twenty per cent. In recent years the two editions of the Journal of the American Pharmaceutical Association likewise have published considerable review material. Numerous other sources augment the supply of recent information; some are in book form, such as recent volumes of Heffter's Handbuch der Experimentallen Pharmakologie, publishing reviews both in German and English; the survey by Anderson, Murayama and Abreu(1); and Recent Advances in Pharmacology by Robson and Keele (2). Others appear in various journals, such as the Journal of the American Medical Association, the Federation Proceedings in the form of symposia, the year books in physiology and biochemistry and in several German journals, such as the recently established Arzneimittel Forschung. The National Research Council also issues material dealing with special fields, such as rodent or malaria control, and the Federal Security Agency of the United States has sponsored comprehensive reviews, such as the Pharmacology of the Opium Alkaloids. Time has not been available to compile a comprehensive list of review sources. However, I do wish to compliment our pharmaceutical manufacturers on their many excellent reviews in their house organs, in brochures and in special books made available to our profession free of charge.

Likewise, in case of the primary sources of information, the scientific articles dealing with results of research in pharmacology, we must, for the sake of brevity, limit ourselves to the list of journals in Appendix C; this list pertains to journals publishing at least in part articles in English and having pharmacology editors. However, we do wish to call attention to the fact that articles dealing with pharmacology frequently appear in journals of associated fields, such as physiology, biochemistry, bacteriology, pathology and medicine.

To be more certain of locating all of the pertinent information about any one subject, often published in foreign journals which are unavailable, one must resort to the various abstract compilations, such as Chemical Abstracts, Biological Abstracts or Excerpta Medica. A survey of titles of articles is available through the Quarterly Cumulative Index Medicus.

Direct information derived from active participation in research in pharmacology is at present limited because all of our pharmacy colleges do not, as yet, have facilities or funds for carrying on such work on any appreciable scale. This is regrettable because, in my opinion, where other factors are equal, the teacher engaged in research should be a better teacher in pharmacology. Finally, attendance at scientific conventions as a source of information will be taken up tomorrow.

In planning his course, the pharmacology instructor is confronted with almost the same problems which face the author of a textbook in selecting the material he wishes to present and determining the relative emphasis to be placed on each topic. The Sub-Committee on Pharmacology and Biological Assay of the Syllabus Committee responsible for the fifth edition (revised) of the Pharmaceutical Syllabus which appeared in 1942 (3) recommended that 112 hours be devoted to lectures and recitations and 80 hours to laboratory work in the combined course covering pharmacology

and bioassay. The total number of 192 hours is the same as that recommended by the Syllabus Committee for the expanded program of pharmaceutical education. (5).

At the University of Nebraska we devote a total of 192 clock hours, consisting of three hours per week of didactic instruction and three laboratory hours per week through the two semester school year to our course in pharmacology. Eight credit hours are granted for this course. In order to impart to the student an appreciation of the importance of bioassay, we describe the principles of some of the assay methods at the time we present the lecture material on these drugs, such as, for example, insulin and Vitamin D. However, the assay procedures for several drugs, such as digitalis, are treated in greater detail in the laboratory periods. Here, a part of the time is used to discuss the principles of these assays and to familiarize the student with the mathematical treatment of the data. Such statistical treatment may include the determination of the LD_{50}, the median lethal dose, and the ED_{50}, the dose effective in fifty per cent of the animals, as well as the standard error and the 't' factor for determining whether or not a difference is significant. In addition to the course in pharmacology, a one-semester, three-credit course in bioassay is available to our students on an elective basis and is recommended to those interested in obtaining further training in this field. An elective three-credit course in therapeutics is also available to senior students.

In the course in pharmacology, five or six of the lecture periods during each semester are used for written tests. At each period immediately following each test, a rapid survey of the correct answers to the examination questions is presented for the purpose of correcting wrong impressions, supplying information found to be lacking, and offering guidance to the reasoning processes of the student in dealing with future examinations. We shall give further consideration to the topic of examinations later in this discussion.

General Plan of Course

In our course we follow the usual procedure of presenting various topics of a more general nature, such as scope of the course, sources of information, incompatibilities, classification of drugs, principles of dosage determination and the relation of chemical structures to pharmacological action. We then prefer to begin our consideration of specific drug actions by taking up first those drugs characterized mainly by local action. By beginning with the less complex actions, we are able to start the laboratory work with several experiments of a more general, although less involved, nature, such as those dealing with irritants and corrosives, methods of administration, and urinary excretion of drugs. However, others following different plans may be equally successful in teaching the subject. As a matter of fact, we have found that we can obtain better correlation between the didactic and the laboratory instruction during the first semester by deferring consideration of the cathartics and anthelmintics until the second semester. We have included some topics which are not always included in every pharmacology course, such as, poison gases in warfare and a special lecture on interrelationships between pharmacology and physiology. A general outline of the course as we offer it at the University of Nebraska is presented in Appendix D.

Relative Emphasis Upon Various Groups of Drugs. Since this outline is available, we shall not discuss further the sequence of topics in the course, but instead take up certain matters pertaining to the presentation of the lecture material. In this connection, we wish to refer again to Appendix A, "A Check List of Important Items of Information Concerning Drugs for Use in Planning a Course in Pharmacology."

A very important problem is that of determining the relative emphasis to be placed upon the various topics or groups of drugs. Since the appearance of the fifth edition of the Syllabus in 1942, new groups of drugs have appeared, and new and important additions have been made to our store of knowledge concerning the older ones. Some guidance in this connection may be obtained by consulting recent textbooks. A detailed examination of two such texts revealed that 16.0 and 18.9 per cent, respectively, of the total space was devoted to depressants of the central nervous system; 14.4 and 12.0 per cent, respectively, to drugs affecting the autonomic nervous system; and 11.6 and 11.3 per cent, respectively, to medicaments employed to combat the various invaders of the body (chemotherapy). This showed fairly close agreement in the relative weights assigned to each of these major groups, and remarkably close agreement in the totals for the three groups, which amounted to almost exactly 42 per cent of the total material in either textbook examined.

Evidence of shifting emphasis is also provided in the deletions and additions in the most recent Pharmacopoeia of the United States, the National Formulary and the New and Non-Official Remedies.

Completeness of Coverage. As a corollary to the question of the relative emphasis to be placed upon the various groups of drugs, there is the question of which drugs to include in addition to the official drugs and those listed in New and Non-Official Remedies. For example, many more barbiturates are known besides the five included in the official compendia. Some of these are recognized by the New and Non-Official Remedies, while others are not. The five official barbiturates represent typical examples of gradations in duration of action, extending from very prolonged to ultrashort. In the list are agents useful as general hypnotics and sedatives, as anticonvulsants and antiepileptics, in psychiatric medicine and obstetrical practice and as typical anesthetics both for men and animals. In addition to the five official barbiturates we usually include several of those listed in New and Non-official Remedies in our lectures and in a laboratory demonstration. However, if time is limited, the five official barbiturates may be considered adequate.

Relative Importance of Qualitative and Quantitative Pharmacology.

Three problems arise involving the balance in emphasis to be placed upon as many pairs of aspects of the subject matter. The first stems from the fact that pharmacology involves both qualitative and quantitative features. To a large extent the balance depends upon the drug in question. However, it is not only important to know the actions and uses of a drug, but also the speed of onset, degree and duration of action, and approximate dosage. Familiarity with the latter quantitative information especially is expected of the pharmacist. When bioassay is involved, the statistical treatment of the data becomes important not only in the planning of the assay procedure, but also in the interpretation of the results. Under the present restrictions in the time available, we are unable to

include the more complicated evaluations, such as those involved in the pituitary assay.

General Description Versus Description of Details of Mechanism of Action. The second problem involving balance of emphasis arises with reference to the general description of the action of a drug (and its therapeutic importance) as contrasted with the fine details of its mechanism of action. As our knowledge of the latter increases, there is grave danger that the student may become lost in the minutiae of the mechanism of action to such an extent that he fails to appreciate the importance of the drug in therapeutics. To be sure, important and generally accepted theories concerning the mechanisms of drug action must be presented for evaluation. On the other hand, the danger of becoming lost in theory must be recognized and avoided.

Individual Drugs Versus Mixtures of Drugs. The third problem involving balance in emphasis arises in connection with the administration of individual drugs as compared with the administration of mixtures. Because of time restrictions, we limit ourselves to the consideration of typical cases, such as the administration of theophylline with mersalyl, an official mixture, procaine with epinephrine, likewise official, or the simultaneous administration of caffeine with analgetics or with certain antihistaminics, together with an explanation of the advantages of such combinations. The danger of simultaneous administration of certain drugs is pointed out in some cases, such as administering mercurials while the patient is taking iodides.

Degree of Correlation with Other Sciences. The instructor in pharmacology must also determine the extent to which correlation with other sciences is necessary to impart to his students maximum comprehension of the subject. For example, that portion of the underlying physiology which the student failed to master, together with that portion he has forgotten since completing his courses in that subject has an important bearing on this question. In this connection, and as a specific example, how detailed a review of the life cycle of the malarial plasmodia is needed to enable the student to gain a full appreciation of the recent advances in the development of the newer antimalarials? No arbitrary rule can be adopted with regard to how much time must be devoted to reviewing basic information presumably covered in prerequisite courses. The instructor should, however, be alert to discover serious deficiencies in knowledge of the basic sciences of his students as early in the course as possible and if such are found, do everything he can within the limitations of the time available to correct this situation.

Concept of An Ideal Drug. As a general principle, we try to impart to the student a clear conception of the properties of the ideal drug for the purpose in hand, such as the ideal hypnotic, general anesthetic, or anthelmintic. It is our hope that as the student enters pharmaceutical practice he will carry with him the mental images of such ideal agents as a part of his permanent mental equipment which he will use better to evaluate new agents of similar therapeutic action.

Historical Aspects of Pharmacology. The historical aspects of pharmacology usually hold a special fascination for the teacher in this field, and through their study he gains a deeper appreciation of his

field of science. Obviously, it is impossible to present the full history of every drug he discusses. However, in selected cases, presentation of historical background serves the dual purpose of enriching the course and relieving the monotony which otherwise is almost unavoidable if the discussions are limited to the actions and uses of drugs. Such information serves to develop in the student a keener appreciation of the human effort that often has been expended to bring about a discovery of a new drug, a new use of a drug, or clarification of an action. If properly presented, brief historical discussions may be of great value as a source of inspiration to students. As examples, we discuss in some detail the discoveries of the early general anesthetics, of ethylene anesthesia, which we were privileged to watch from the '50-yard line,' and of insulin. We shall refer to this phase of instruction in pharmacology tomorrow when we discuss the qualifications of the good instructor.

Sociological Implications of Pharmacology. Finally, the instructor must determine the relative emphasis to be placed upon the sociological implications arising from the pharmacological actions of certain drugs and poisons. In many instances, the social problems which arise are manifold, as is the case with alcohol. Excessive consumption of alcohol has a direct bearing on the safety of automobile driving, the instigation of crime, the acquisition of social diseases, the tendency toward quarrelsomeness, the ability to support a family and the matter of treating the alcoholic. Overindulgence in the smoking of tobacco poses the problem of considerable expense, a possible effect on longevity and incidence of pulmonary cancer, a fire hazard if practiced while in bed, and the occurrence of various symptoms resulting from excessive smoking. Addiction to morphine, heroin, cocaine and marihuana and habituation to the barbiturates presents serious legal problems and involves untold human misery. The intense suffering following exposure to certain poison gases employed in warfare places equally weighty problems on those entrusted with guiding the destiny of the human race. I shall leave to Dr. Muehlberger the discussion of industrial hazards, another phase which affects society on a wide scale. Likewise, I shall leave to Dr. Swinyard the sociological aspects of vivisection because these pertain primarily to laboratory instruction.

Objective Methods of Testing the Knowledge of the Student

An important part of the teaching of any course is the testing program used to determine the progress of the student in meeting the objectives of the course. In pharmacology these may be stated in their most condensed form as follows:

"1. The acquisition of the terminology or vocabulary distinctive to the course.
2. The acquisition of the principles nad other factual information.
3. The ability to apply the knowledge of facts and principles in the interpretation of situations or problems." (5)

A somewhat more detailed list of objectives is found in the Pharmaceutical Syllabus, fifth edition (revised). (3)

It should be emphasized at this point that the student entering the course in pharmacology is usually a senior, or at least a junior. Hence, he has been screened first of all by having qualified under more or less restrictive admissions requirements, and by having successfully

passed his prerequisite courses, usually meeting requirements for grades substantially above the minimum passing grade.

Relative Difficulty of Questions. As a general policy, we endeavor to devise examination questions in such a way that most of the properly prepared students can answer at least sixty per cent of these with little or no difficulty; another twenty per cent of the questions require some meditation and reasoning and the remaining twenty per cent consist of more difficult questions which are included for the express purpose of differentiating between the superior students and their classmates.

Another procedure for constructing examinations consisting of objective questions is recommended by Anderson. In condensed form it consists of dividing completely scored examination papers into an upper, middle and lower third, according to the total scores, and then calculating for each question or item the percentage of correct answers for each of the three groups. Finally, all questions which are found to be clearly too easy or too difficult for all groups, as shown by these results, are eliminated from further consideration. In other words, he retains for future use only those questions which clearly discriminate among the three groups. In our own case, the twenty per cent of our questions requiring some thought or reasoning serves to differentiate the lower group from the two higher groups, while the more difficult twenty per cent of the questions help us identify the members of the superior group.

Inasmuch as we have had no formal training in testing methods, our knowledge has been limited to what we could gain by reading, consultation with experts, and through practical experience. In view of this, we trust that the experts in this field will bear with us if we limit our discussion of this phase of the teaching of pharmacology to the listing of examples of questions taken from some of our tests (Appendix E) with brief comments on the kinds of questions used.

In connection with the subject of improvement of examinations, we wish to refer to two recent articles by Thurstone and by Caplow (7, 8). A manual of questions in pharmacology in objective form, as suggested by Thurstone, would, indeed, be a boon as a source of questions and as a model for making up new ones as pharmacology progresses. See also the article by Harris on "Suggested Methods for Achievement Testing," (9) and the discussion by Christensen on objective tests. (10)

A. The Direct Answer Type of Question. A considerable part of our examinations involves questions which can be answered by a brief statement, as the action of a drug upon a given function or organ, the site of action, or the method of administration. We instruct students to employ elucidating adjectives or adverbs and to avoid telegraphic style; even so, incomplete answers seem difficult to avoid. Thus, when the student is asked to diagnose the following condition from the symptoms given: wrist drop, pallor, and intestinal colic, he frequently gives 'lead poisoning' without the word 'chronic'. An answer stating merely that a drug 'acts' on a given part of the body or upon a stated bodily function, without giving the type of action (stimulation, depression, increase, decrease, etc.) is one of the most frequent deficiencies we have noted. Likewise, an answer reading simply 'injection' without specifying the kind of injection is common. In asking for a definition, such as for 'bromism' or for 'tachyphylaxis,' students very considerably in their ability to give a clear definition.

More elaborate questions are readily devised to ascertain the critical abilities of students. Thus, a question may call for differentiation between two major drugs, such as atropine and cocaine, by pharmacological methods exclusively and listing of the expected results which will bring out the differences with certainty. When the student is uncertain as to which methods are valid, he frequently resorts to vague answers. This type of question is simplified by asking for a comparison of two drugs of similar type in regard to a specified set of conditions, such as phenobarbital and hexobarbital in their speed and duration of action, the proportion of each excreted in the urine, and so on. Completeness of knowledge may also be measured by asking the student a series of questions requiring practical application of his knowledge. An example of such a question is to ask the student to list and give the reasons for the precautions in interpreting data from testing for alcoholic intoxication. Another example of the more involved type is to list four drugs having appropriate actions, such as atropine sulfate, magnesium chloride, pilocarpine nitrate, and barium chloride, and ask the student to arrange these in proper order to produce consecutive alternate effects of stimulation and depression on an isolated intestinal strip and give reasons for the sequence he recommends. Still another type of direct question consists of asking for the identification of the agent administered to an animal, as determined from graphic records from a laboratory experiment. Further examples of questions of this and subsequent types are found in Appendix E.

B. The Completion Type of Question. We often use the completion type of question in our tests. These may involve a single answer, as in the statement, 'Atropine causes _____ of the pupil of the eye.' They may also be utilized to bring out a relationship, as in a statement such as: 'The therapeutic index is determined by dividing the _____ by the _____.'

This type of question when involving reversed definitions often causes considerable difficulty to the student where a pharmacological term or principle is involved, as illustrated by the question: 'What is the term applied to the phenomenon of gradually diminishing rises in blood pressure noted when hourly intravenous injections of ephedrine sulfate are continued for about five hours?'

C. The Modified True-False Type of Question. One type we frequently use is a modified true-false question. If an underscored portion of a statement is correct, the student is expected to indicate this by placing the letter T in the space provided on the margin opposite the statement; on the other hand, if the statement is false, the student is not expected to indicate this, but is instructed, instead, to write in the space provided a revised version of the underscored portion which will make the statement true. An example of such a statement is: 'Morphine is a glucoside.' This requires the substitution of the word 'alkaloid' for the 'glucoside.' To state morphine is 'not' a glucoside is unacceptable. We do not supply a list of possible answers with questions of this type, since the inclusion of the correct answer in such a list undoubtedly makes it much easier for the student to answer the question.

In our experience, the student encounters greater difficulty if he is asked to discover and correct all errors in a paragraph or statement in which errors have been introduced. These errors are not identified

by number or other symbols. The student is instructed to underscore each error and correct it with a minimum number of words. In no case is the name of the first drug mentioned in the statement to be changed. Thus, in the statement: 'Intravenous injection of a suitable dose of epinephrine hydrochloride causes approximately a forty-minute rise in blood pressure,' he cannot substitute 'ephedrine' for 'epinephrine', but must change 'forty' to 'five'. This modification of the true-false test involving the correction of all false statements may be extended to a running description of the treatment of an acute poisoning, in which false statements involving the order of the steps taken, delay in initiating the treatment, the solvent used for lavage, the physiological antidote, and other pertinent matters may require correction. Here, again, the errors are not identified in any way and no list of suggested corrections is supplied.

D. The Multiple Choice Type of Question. We also use the multiple choice question, in both the single- and the multiple-response form. In the single-response question, we usually offer a choice of five answers, carefully avoiding any that are leading or ludicrous. In the multiple-response question, we list several drugs and ask the student to place the symbol identifying the appropriate statement or word in the master list of answers opposite the drug to which the answer applies. Some of the answers listed apply to several of the drugs, others apply to none of them. Thus, if, for example, 'cocaine' and 'atropine' are both in the list of drugs, the answer, 'dilates the pupil of the eye,' applies to both, while 'produces local anesthesia when applied to the eye,' fits 'cocaine' only, and 'is an hypnotic,' agrees with neither. We have found that very few students make perfect scores on questions of this type where five drugs are to be matched with a list of about twenty possible answers.

Occasionally, we have used questions of the reverse multiple-choice type. Listings of five things, four of which belong to the same class, are prepared. The student is asked to delete the name which does not belong in the same class with the others, and designate the category to which the other four belong. In stating such questions, extreme care must be exercised to avoid two or more correct answers. Thus, in a list consisting of: 'strychnine,' 'picrotoxin,' 'nikethamide,' 'paraldehyde,' and 'pentylentetrazol,' one may state that four are 'convulsants' and one 'a central nervous system depressant;' but it would be equally correct to state that four 'are solids,' and one is 'a liquid.' Substitution of 'pentobarbital,' for 'paraldehyde,' would rule out the second possibility.

Conclusion

In this brief discussion, intended primarily for the beginning instructor in pharmacology, we have pointed out certain differences between curricula in the medical and pharmacy schools and discussed the amount of time allotted to the course. However, the main emphasis has been placed upon three major topics, namely, the sources of information in pharmacology, with special emphasis upon the variations in textbooks, with the problems arising in planning the course, and finally, the methods of determining the progress of the student by means of examinations. To further aid the beginner we have included a short bibliography and supplemented the material with a series of five appendices

dealing with important items of information concerning drugs, a list of textbooks, a list of journals, a syllabus of the course, and examples of examination questions, respectively.

REFERENCES

1. Anderson, H. H.; Muryama, F.; and Abreu, B. E., Pharmacology and Experimental Therapeutics, A Survey for 1941-46, University of California Press, 1947.

2. Robson, J. M. and Keele, C. A., Recent Advances in Pharmacology, The Blakiston Company, Philadelphia, 1950.

3. The Pharmaceutical Syllabus, 5th edition (tentative), pp. 141-146. The National Pharmaceutical Syllabus Committee, 1942.

4. Webster, J. L., Committee on Curriculum, American Journal of Pharmaceutical Education, 12, 765, 1948.

5. Johnson, P. O., Studies in College Examinations, University of Minnesota, Committee on Educational Research, p. 43, 1934.

6. Anderson, J. E., ibid., pp. 116-120.

7. Thurstone, L. L., The Improvement of Examinations, American Association of University Professors Bulletin, 34, 394-397, 1948.

8. Caplow, T., ibid., 37, 57-64, 1951.

9. Harris, C. W., American Journal of Pharmaceutical Education, 14, 69-76, 1950.

10. Christensen, B. V., ibid., 2, 51-55, 1938.

APPENDIX A

BY H. O. HOLCK

A CHECK LIST OF IMPORTANT ITEMS OF INFORMATION CONCERNING DRUGS FOR USE IN PLANNING A COURSE OF LECTURES ON PHARMACOLOGY

A. Nomenclature and Synonymy of the Drug.
   1. Latin title?
   2. English title?
   3. Common Synonym?
   4. Proprietary or copyrighted names?
   5. Official in U. S. P., N. F., B. P. or listed in N. N. R.?

B. History of the Drug.
   1. When discovered?
   2. By whom?
   3. How discovered?
   4. Where discovered?

C. Physical Nature and Properties.
   1. Is it a solid, liquid or gas at ordinary temperatures?
   2. Is it highly volatile, inflammable or explosive?
   3. Is it caustic?
   4. Is its odor or taste characteristic, pleasant or objectionable?
   5. If objectionable, can the taste be disguised, and if so, by what means?
   6. Is the color characteristic?
   7. Is it sufficiently soluble in water or some other suitable solvent so that it may be injected? Is a suspension practical for such purposes?
   8. Must other solvents, such as alcohol, be used to extract the active principles?

D. Chemical Nature and Properties.
   1. If known, what is its chemical structure?
   2. Is it related chemically to drugs used previously to develop the same or similar action(s)?
   3. How pure can it be made?

4. How costly is it?
5. How stable is it?
6. Are special conditions helpful or necessary in preserving it, such as refrigeration, oxygen exclusion, high or low pH adjustments or addition of an antiseptic?
7. What are its principal chemical incompatibilities?

E. Uses and Main Action or Actions Upon or Within the Body.
1. For what purpose is it used?
2. How promptly does it act?
3. Where and how does it act?
4. How much action may be expected from a safe dose?
5. What is the duration of action?
6. What is its fate in the body?
7. How may satisfactory action be recognized?
8. What substances may be administered with it to improve its action, or for corrective purposes?
9. Is its use restricted by federal or state laws or regulations?

F. Methods of Administration.
1. What dosage form is best suited to its administration, that is, as tablet, tincture, solution, ointment, etc.?
2. What mode of administration is best: oral, by inhalation, by one of the injection techniques, by local application, or by some special method?

G. Safety of the Drug.
1. What is the relation between the usual and the toxic or fatal dose?
2. Will a considerable proportion of patients develop undesirable symptoms with ordinary dosage, such as nausea or eczema?
3. Is it dangerous to administer several doses in rapid succession, or will tolerance or fastness develop, necessitating increased dosage or change of drug?
4. If given for local action, is it likely to be absorbed, producing toxic symptoms?
5. Is it habit-forming, and if so, is there danger of causing serious addiction?
6. Are physiological or therapeutic incompatibilities likely to occur?
7. Is automatism with possible dire consequences likely to develop?

4. How costly is it?
5. How stable is it?
6. Are special conditions helpful or necessary in preserving it, such as refrigeration, oxygen exclusion, high or low pH adjustments or addition of an antiseptic?
7. What are its principal chemical incompatibilities?

8. Uses and Mode (action or lesions) Upon or Within the Body.
1. For what purpose is it used?
2. How promptly does it act?
3. Where and how does it act?
4. How much action may be expected from a safe dose?
5. What is the duration of action?
6. What is its fate in the body?
7. How may satisfactory action be recognized?
8. What substances may be administered with it to improve its action, or for corrective purposes?
9. Is its use restricted by federal or state laws or regulations?

9. Method of Administration.
1. What dosage form is best suited to its administration, that is, as tablet, tincture, solution, ointment, etc.?
2. What mode of administration is best: oral, by inhalation, by one of the injection techniques, by local application, or by some special method?

10. Toxicity or Side Effects.
1. What is the relation between the usual and the toxic or fatal dose?
2. Will a reasonable proportion of patients develop undesirable symptoms with ordinary dosage, such as nausea or nausea?
3. Is it dangerous to administer several doses in rapid succession, or will tolerance or fastness develop, necessitating increased dosage or change of drug?
4. If given for local action, is it likely to be absorbed, producing toxic symptoms?
5. Is it habit-forming, and if so, is there danger of causing serious addiction?
6. Are physiological or therapeutic incompatibilities likely to occur?
7. Is automatism with possible dire consequences likely to develop?

H. Toxic Potentialities of the Drug.

1. What toxic signs and symptoms are likely to occur in cases of hypersensitivity or of overdosage, either by accident or intent?
2. How do these aid in differentiating one case of poisoning from another?
3. Is there danger of cumulative action or injury?
4. If untoward or toxic symptoms appear, how may the patient best be treated?
5. How important is promptness in initiating such treatment?
6. What precautions should be observed to prevent the person administering such treatment also from being poisoned?

I. Bioassay of the Drug.

1. If it is impossible to assay a drug by physical and chemical methods, is there a simple, inexpensive and accurate method by which it may be assayed biologically?
2. Is the method official?
3. What is the reference standard, if one is used?
4. Which animal is most suitable for the response in question?
5. What are the specifications for such an animal and how many are required?
6. To what extent must the environment and the diet be controlled?
7. What consideration must be given to choice of solvent and solution to be employed?
8. Which technique of drug administration is required?
9. Must the assay be completed within a limited period?
10. How are the results best treated statistically?
11. How many of the following factors or specific conditions must also be considered: Seasonal variation, choice of anesthetic, standardization of the animals used, and the need for cross-over tests?

B. Toxic Potentialities of the Drug

1. What tissue edema and symptoms are likely to occur in cases of hypersensitivity or of overdosage, either by accident or intent?
2. How do tissue aid in differentiating one case of poisoning from another?
3. Is there danger of mutagenic action or injury?
4. If untoward or toxic symptoms appear, how may the patient best be treated?
5. How important is promptness in initiating such treatment?
6. What precautions should be observed to prevent the person administering such treatment also from being poisoned?

I. Discovery of the Drug

1. If it is impossible to study a drug by physiological chemical methods, is there a simple, inexpensive and accurate method by which it may be assayed biologically?
2. Is the method official?
3. What is the reference standard, if one is used?
4. Which animal is most suitable for the purpose in question?
5. What are the specifications for such an animal and how many are required?
6. To what extent must the environment and the diet be controlled?
7. What considerations must be given to choice of solvent and solution to be employed?
8. Which technique of drug administration is required?
9. Must the assay be conducted within a limited period?
10. How are the results best treated statistically?
11. How many of the following factors or specific conditions must also be considered: Seasonal variation, choice of anesthetic, standardization of the animals used, and the need for cross-over tests?

APPENDIX B

BY H. O. HOLCK

A LIST OF TEXTBOOKS OF PHARMACOLOGY AND THERAPEUTICS

Bastedo, A., Pharmacology and Therapeutics. 5th Edition, W. B. Saunders Co., 1947. $8.50.

Burn, J. H., Lecture Notes on Pharmacology. Charles C. Thomas, 1949. $1.60.

Davison, F. R., Handbook of Materia Medica, Toxicology and Pharmacology for Students and Practitioners of Medicine. 4th Edition, C. V. Mosby, 1949. $8.50.

Gaddum, J. H., Pharmacology. 3rd Edition, Oxford University Press, 1948. $8.00.

Ghash, B. N., Pharmacology, Materia Medica and Therapeutics. 17th Edition, Lewis and Co., Ltd. (136 Gower St., London W.C.1.), 1947. 21s.

Goodman, L. and Gilman, A., Pharmacological Basis of Therapeutics. The Macmillan Co., 1941. $12.50.

Grollman, A., Pharmacology and Therapeutics; A Textbook for Students and Practitioners of Medicine. Lea and Febiger, 1951. $10.00.

Gunn, J. A., An Introduction to Pharmacology and Therapeutics. 8th Edition, Oxford University Press, 1948. $2.25.

Hale-White, W., Materia Medica, Pharmacy, Pharmacology and Therapeutics. 27th Edition, J. A. Churchill, Ltd., London, 1948. 15s.

Krantz, J. C. and Carr, C. J., Pharmacologic Principles of Medical Practice. 2nd Edition, The Williams and Wilkins Co., 1951. $10.00.

Marsh, D. F., Outline of Pharmacology. Charles C. Thomas, 1951. $5.50.

Melton, H., Concise Pharmacology. 3rd Edition, Chemical Publishing Co., 1950. 15s.

Micks, R. H., Essentials of Materia Medica, Pharmacology and Therapeutics. 4th Edition, J. A. Churchill, Ltd., London, 1947. 18s.

Mulinos, M. G., Pharmacology. 2nd Edition, Oxford University Press, 1951. $5.00.

Oldham, F. R., Kelsey, F. E. and Geiling, E. M. K., Essentials of Pharmacology. J. B. Lippincott Co., 1947. $5.00.

Sollmann, T. H., A Manual of Pharmacology. 7th Edition, W. B. Saunders Co., 1948. $11.50.

Thienes, C. H., Fundamentals of Pharmacology. Paul B. Hoeber, Inc., Medicine Book Department of Harper and Brothers, 1947. $5.75.

BIOASSAY

Burn, J. H., Finney, D. J., and Goodwin, L. G., Biological Standardization, 2nd Edition, Oxford University Press, 1950. $6.75.

Haley, Th. J., *et al.*, text scheduled for 1952, Lea and Febiger.

APPENDIX C

BY H. O. HOLCK

A LIST OF JOURNALS OF PHARMACOLOGY

1. Acta Pharmacologica et Toxicologica
2. Anesthesia and Analgesia
3. Archives Internationales de Pharmacodynamie et de therapie
4. British Journal of Pharmacology and Chemotherapy
5. Endocrinology
6. Journal of the American Medical Association
7. Journal of the American Pharmaceutical Association, Scientific Section
8. Journal of Endocrinology
9. Journal of Industrial Hygiene and Industrial Toxicology
10. Journal of Laboratory and Clinical Medicine
11. Journal of Pharmacology and Experimental Therapeutics
12. Journal of the Society of Experimental Biology and Medicine
13. Pharmacological Reviews
14. Quarterly Journal of Pharmacy and Pharmacology, incorporating the Yearbook of Pharmacy

For a very extensive list of journals of interest to pharmacologists see: Hocking, G. M., Periodicals Pertaining to Pharmacology, A Preliminary List, American Journal of Pharmaceutical Education, 234-242, 1943. See also Lee, C. O., Report of the Committee on Libraries, ibid., 14, 613-624, 1950.

APPENDIX D

A SYLLABUS OF THE UNDERGRADUATE DIDACTIC WORK IN PHARMACOLOGY AS GIVEN AT THE COLLEGE OF PHARMACY OF THE UNIVERSITY OF NEBRASKA

1. Introductory Topics.
   Definition and subdivisions, historical background, present status, general social aspects, classification, mode of action, theories, relative sensitivity, history of toxicology, general principles involved in toxicology, principles for the treatment of poisoning, incompatibilities, dosage.

2. Locally Acting Drugs.
   Irritants, inflammation, astringents (lead poisoning), demulcents, emollients, gums, fixed oils, substances used to stimulate skin healing, acids and bases, including poisoning, salts, phosphorus poisoning, poison ivy and poison oak, chemical substances in warfare, nitrogen mustards.

3. Locally Acting Antiseptics.
   Definition of terms, phenol coefficient, examples of group, phenol poisoning, formaldehyde poisoning, urinary antiseptics, intestinal antiseptics, amebicides.

4. Chemotherapeutic Agents.
History, the sulfonamides, problems concerning their use, the antibiotics.

5. Emetics and Counteraction of Vomiting.
Methods of eliciting vomiting, locally acting emetics, centrally acting emetics, prevention of emesis.

6. Expectorants and Cough Sedatives.

7. General Anesthetics.
History, types, stages of anesthesia, methods of administration, theories, ideal anesthetic, dangers during anesthesia, examples of volatile anesthetics, basal anesthesia and agents employed to accomplish this. Magnesium depression.

8. Aliphatic Alcohols.
Examples. Social implications of alcoholic intoxication.

9. Sedatives and Hypnotics.
Bromides, ideal hypnotic, examples, relation of chemical structure to action, variety of uses, dangers, antiepileptics.

10. Opium Alkaloids.
Differences among components, uses, addiction, legal restrictions, other addicting analgesics, marihuana, synthetic addicting analgesics.

11. Local Anesthetics.
Ideal local anesthetic, cocaine and cocainism, synthetic local anesthetics.

12. Cholinergic Nerve Inhibitors.
Brief review of autonomic nervous system, classification of autonomic drugs, cholinergic blocking agents. Scopolamine depression.

13. Histamine and Antihistaminics.

14. Cholinergic Nerve Stimulatants.
Examples, iontophoresis, muscarine and mushroom poisoning.

15. Autonomic Ganglia and Skeletal Muscle Inhibitors.
Nicotine and smoking, curare and curariform agents, tetraethylammonium salts.

16. Adrenergic Nerve Inhibitors.
Ergot and ergot alkaloids, other adrenergic blocking agents.

17. Adrenergic Nerve Stimulatants (Sympathomimetic Agents).
History, natural and synthetic examples, relation of chemical structure to action, synergism and antagonism to cocaine, principles of bioassay of epinephrine.

4. Chemotherapeutic Agents.
History, the enforcement, problems concerning their use, the antidotes.

5. Emetics and Counteraction of Vomiting.
Methods of eliciting vomiting, locally acting emetics, centrally acting emetics, prevention of emesis.

6. Antidiarrheals and Cough Medicines.

7. General Anesthetics.
History, types, stages of anesthesia, methods of administration, theories, ideal anesthetic, dangers during anesthesia, comparison of volatile anesthetics, basal anesthesia and agents employed to accomplish this. Hypnotics dependence.

8. Alkaloid Poisons.
Examples. Social implications of alcoholic intoxication.

9. Sedatives and Hypnotics.
Chronides, ideal hypnotic, examples, relation of chemical structure to action, variety of uses, dangers, antidotes.

10. Opium Alkaloids.
Differences among preparations, uses, addiction, legal restrictions, other addicting analgesics, meribidine, synthetic addicting analgesics.

11. Local Anesthetics.
Ideal local anesthetic, cocaine and cocainism, synthetic local anesthetics.

12. Cholinergic Nerve Inhibitors.
Brief review of autonomic nervous system, classification of autonomic drugs, cholinergic blocking agents. Scopolamine deprivation.

13. Metabolism and Anticholesterolytics.

14. Cholinergic Nerve Stimulants.
Examples, lontophoresis, muscarine and mushroom poisoning.

15. Autonomic Ganglia and Skeletal Muscle Inhibitors.
Nicotine and sucking, curare and curariform agents, ketamethyl-ammonium salts.

16. Adrenergic Nerve Inhibitors.
Ergot and ergot alkaloids, other adrenergic blocking agents.

17. Adrenergic Nerve Stimulants (Sympathomimetic Agents).
History, natural and synthetic examples, relation of chemical structure to action, synergism and antagonism to cocaine, pathogenesis of biosassy of epinephrine.

18. Pituitary Gland.
Pituitrine and its components, criteria of a gland of internal secretion, anterior lobe hormones.

19. Central Nervous System Stimulants.
Xanthine group (review of factors involved in diuresis, saline and mercurial diuretics), strychnine, newer analeptics. Oxygen and oxygen-carbon dioxide mixtures.

20. Modifiers of the Cardiovascular System.
Review of circulatory functions and defects, nitrites, digitalis group, quinidine.

21. Antimalarials.
History, malarial cycle, types of malaria, difficulties in completely curing malaria, quinine, recent antimalarials.

22. Antisyphilitics.
Mercury, mercury poisoning, arsenicals, bismuth, iodides; refer back to antibiotics.

23. Antimony Compounds.
Brief review of selected oriental diseases, examples of antimony compounds in their treatment.

24. Anthelmintics.
General principles of therapy, types of intestinal helminthes, ideal anthelmintic, examples.

25. Cathartics.
General features of their use, classes, examples.

26. Analgesics and Antipyretics.
Antipyretic and antirheumatic analgesics.

27. Thyroid Gland; Antithyroidal Drugs.
Iodine and iodides in relation to thyroid; thyroid dysfunctions, discovery and synthesis of thyroxin, principles of administration; propylthiouracil.

28. Parathyroid Glands.
Calcium and its uses; parathyroid function and dysfunction; effects of parathyroidectomy; parathormone; dihydrotachysterol (barium, strontium, thorium dioxide).

29. Liver, Iron and Vitamin K.
Fate of iron; iron in anemias, history of use of liver in pernicious anemia; liver and stomach preparations; Vitamin B 12.

30. Adrenal Cortex.
Adrenal cortex functions and dysfunctions, adrenal cortex preparations and their history; assay methods.

18. Pituitary Gland.

19. Central Nervous System Stimulants.

20. Nephritis of the Cardiovascular System.

21. Antimalarials.

22. Antidotes.

23. Antimony Compounds.

24. Antibodies.

25. Cathartics.

26. Analgesics and Antipyretics.

27. Thyroid Gland; Antithyroidal Drugs.

28. Parathyroid Glands.

29. Liver, Iron and Vitamin K.

30. Adrenal Cortex.

31. Insulin.
History of discovery, general picture of diabetes mellitus, insulin dosage and administration, newer insulin preparations, bioassay of insulin.

32. The Female and Male Sex Hormones.
Functions and dysfunctions of sex glands; treatment of dysfunctions; additional uses of sex hormones.

33. Vitamins.
Historical development, classification, sources, deficiency diseases and their diagnosis; complex vitamins; individual vitamins; relation of vitamins to tooth formation.

34. Snake Venom and Antivenins.
Variation in species resistance, types of venomous snakes, treatment of poisoning.

35. Toxicology of the Blood.
General discussion; carbon monoxide, cyanides.

36. Insecticides and Rodenticides.
Examples, danger of poisoning in man.

37. Interrelationships of Pharmacology and Physiology.
Discussion of the value of pharmacological agents in studies upon bodily functions.

31. Insulin.
History of discovery, general picture of diabetes mellitus,
insulin dosage and administration, newer insulin preparations,
bioassay of insulin.

32. The Female and Male Sex Hormones.
Functions and dysfunctions of sex glands; treatment of dysfunctions;
medicinal uses of sex hormones.

33. Vitamins.
Historical development, classification, sources, deficiency
diseases and their diagnosis; complex vitamins; individual
vitamins; relation of vitamins to tooth formation.

34. Snake Venom and Antivenin.
Variation in species resistance, types of venomous snakes,
treatment of poisoning.

35. Toxicology of the Blood.
General discussion; carbon monoxide, cyanides.

36. Insecticides and Rodenticides.
Examples, danger of poisoning in man.

37. Interrelationships of Pharmacology and Physiology.
Discussion of the value of pharmacological agents in studies
upon bodily functions.

APPENDIX E

by

H. O. Holck

EXAMPLES OF EXAMINATION QUESTIONS
CLASSIFIED ACCORDING TO TYPE

A. Direct Answer Type of Questions.

1. Give two methods used in evaluation of new antihistaminic drugs in animals.
2. Compare the effect of adding sodium chloride to phenol and to mercuric chloride. Explain briefly the action of sodium chloride upon the efficiency of mercuric chloride as an antiseptic.
3. Name three measures necessary to make methenamine an effective urinary antiseptic; they must be of different nature. Tell why each measure is important.
4. By counting the erythrocytes in acute phosgene poisoning, how can one tell whether or not a person is recovering?
5. What is the best oral antidote in oxalate poisoning? How does this antidote help?
6. Give four differences in the pharmacological actions of ephedrine and epinephrine. Tabulate the answers.
7. From all of the pharmacological experiments of this semester, employ and describe briefly four methods only by which a two per cent watery solution of cocaine hydrochloride can be differentiated or told from a two per cent watery solution of procaine hydrochloride. In each case give the results expected with cocaine and with procaine, respectively.

B. Completion Type of Questions.

1. Atropine _____ the actions of pilocarpine.
2. The distribution coefficient of ether is determined by dividing the amount of ether dissolved in _____ by the amount dissolved in _____.
3. In acute phenol poisoning, repeated gastric lavage with _____ is carried out and the skin and mucous membrane lesions are washed with _____.
4. In each of the following cases add the name of the specific pharmacological principle or term illustrated. There may be several answers in some cases. Example: Tannic acid and phenol in one prescription. 'Chemical Incompatibility.'

a. Depression of the motor cortex of the brain, but not of other parts by mephobarbital:
b. Administering calcium gluconate by vein to a rabbit that has been depressed by intramuscular injection of magnesium sulfate:
c. Restlessness and nervousness when administration of a drug is suddenly stopped after it has been taken daily for several weeks:
d. A large difference between the fatal and the hypnotic dose of a drug:

C. Modified True-False Type of Questions.

1. If the underscored, numbered statement is correct, put a T at the corresponding number in the right hand margin. If

1. _____

2. _____

incorrect, substitute the correct word or words. Subtraction will be made for wrong answers.

Atropine is the most important 1. alkaloid in the leaves of the deadly night-shade. Atropine is employed in opthalmology because of its powerful 2. miotic action; one commonly applies two drops of a 3. 10% solution of atropine sulfate to each eye; one difficulty is that the action is over in about 4. 15 minutes. Half an hour after injecting one milligram of atropine sulfate there is 5. acceleration of the heart rate in a young adult person due to 6. vagal stimulation. A therapeutic dose of atropine 7. suppresses sweating, thus 8. decreases the patient's heat loss. A typical example of 9. physical incompatibility in pharmacology is demonstrated by giving one mg. of atropine sulfate 15 minutes after 20 mg. of pilocarpine nitrate.

3. _____

4. _____

5. _____

6. _____

7. _____

8. _____

9. _____

2. In as many ways as possible comment critically upon each of the following treatments. Where criticism is needed, suggest the best, single, specific alternative treatment.

   a. A person has swallowed 30 cc. of concentrated sulfuric acid at 10:00 a.m. At 10:05 a.m. inject 20 mg. of apomorphine hydrochloride subcutaneously.

   b. A person has swallowed 20 cc. of paraldehyde at 10:00 a.m. At noon administer 25 cc. of one per cent copper sulfate solution by stomach tube.

D. Multiple Choice Type of Questions.

1. Unless otherwise specified, it is assumed that therapeutic range doses are under consideration in the section which follows. Four substances are listed together with 20 statements which may (or may not) apply to any one or more of the agents specified.

   Place the letter identifying the particular substance involved immediately following each and every statement which applies, or makes a true statement, with reference to that particular substance. (Each of the 20 statements should be examined with reference to its accuracy when applied to each of the four substances). Subtraction will be made for wrong answers.

A. Cocaine B. Barbital C. Sodium Bromide D. Paraldehyde

1. Is an alkaloid:
2. Is a liquid:
3. Has distinct odor:
4. Can be smelled on the breath:
5. Excretion greatly favored by giving sodium chloride:
6. Forms salt with HCl:
7. Forms a salt with NaOH:
8. Used in treating epilepsy:

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

7. _____

8. _____

9. _____

A. Cocaine B. Barbital C. Sodium Bromide D. Paraldehyde

9. Is a long acting hypnotic:
10. Has no U.S.P. dose:
11. Causes mydriasis:
12. U.S.P. dose is 1.0 Gm.:
13. Given to patients with nervous insomnia:
14. Synergistic with epinephrine:
15. Local anesthetic for the cornea:
16. Half or more excreted by kidneys in unchanged form:
17. Clonic convulsions seen after toxic doses:
18. Used for local action in the nose.
19. Name the one drug only which is usually given several times daily:
20. Falls under special federal or state law:

2. In the earlier stages of poisoning the following substances cause asphyxia or respiratory difficulties. In the parenthesis after each drug or poison put the ONE LETTER ONLY from the list of possible mechanisms which most likely causes the asphyxia. WRITE PLAINLY.

1. Carbon monoxide ( )
2. Chloroform ( )
3. Potassium Cyanide ( )
4. Sodium nitrite ( )
5. Physostigmine ( )

A. Causes hemolysis
B. Constricts the bronchioles
C. Forms stable hemoglobin compound
D. Depresses respiratory center
E. Paralyses endings of prenic nerves
F. Much methemoglobin forms
G. Paralyses the diaphragm directly
H. Combines with oxygen in the inhaled air
I. Paralyses ferments needed for utilizing the oxygen of the blood

3. Underscore the drug or condition which does not belong in the same category as the others. ALSO, tell very briefly what groups the others together:

a. Myxedema - Addison's disease - Rickets - Diabetes mellitus- Diabetes insipidus
b. Senna - Agar agar - Cascara sagrada - Santonin - Rhubarb
c. Digitoxin - Quinine - Atropine - Pilocarpine - Strychnine.

THE UNDERGRADUATE COURSE IN PHARMACOLOGY — LABORATORY

Ewart A. Swinyard
University of Utah, College of Pharmacy
Salt Lake City, Utah

Although pharmacology is a basic pharmaceutical science in its own right, it borrows freely from and contributes generously to the subject matter and technics of other pharmaceutical disciplines. It accepts, from pharmaceutical chemistry, structure-activity-relationships which are important in understanding the mechanism of drug action. It draws, from courses in pharmacy, the forms of drug administration and their application to routes of administration. It utilizes information, from pharmacognosy, concerning the source, active constituents and physical characteristics of naturally occurring drug products. On the other hand, pharmacology repays with interest the pharmaceutical chemical approach to structure-activity-relationships by opening new fields of synthesis. To basic pharmacy courses it contributes information concerning the efficacy of various vehicles, bases and galenical combinations. To pharmacognosy it provides a useful tool for revealing Nature's therapeutic secrets.

The professional knowledge which the practitioner of retail pharmacy uses most frequently, whether it be in selling or rendering a service to the health professions, is that which deals with pharmacological problems. It is the pharmacist's knowledge of this subject which helps to protect the public from nostrums and drugs of questionable therapeutic value. It enables the pharmacist to guard the health of the community by recognizing the need for prompt medical attention. His knowledge of the action and therapeutic use of the many new and potent drugs enables him to be a source of information for the medical profession. In times of emergency, such as individual poisonings and community disasters, his knowledge of pharmacology is of great practical value. A recent prescription survey in the State of Utah shows that only seven per cent of prescriptions require compounding (1). Therefore if this situation obtains in other states it is quite obvious that the pharmacist of today has only limited opportunity to apply the basic technics acquired in courses in pharmacy, pharmacognosy and pharmaceutical chemistry. Does this state of affairs imply that a knowledge of solubility, stability, ionization, incompatibles, etc., is becoming of lesser importance to the practicing pharmacist? In any event the pharmacist should understand the mechanism of action, therapeutic use, dosage and toxicity of every prescription he handles, whether it requires compounding or is dispensed as manufactured. Therefore, it is apparent that pharmacology should occupy an important position in the pharmacy curriculum.

In such a discussion it is well to remember that our primary objective is to train retail pharmacists and not specialists in the various pharmaceutical disciplines. Therefore, prejudice and self interest should be set aside in favor of educational principles which will provide the student pharmacist with the best training for his chosen profession. In view of present day prescription trends, it is apparent that such a program should include a practical understanding of pharmacology. Inasmuch as one learns most readily by doing, laboratory work should be an integral part of this training.

The laboratory method of teaching is time-consuming and costly. The majority of students are unskilled in laboratory methods and require more time for this type of instruction. In addition, special equipment and required materials make laboratory instruction one of the most costly of all educational procedures. Properly used, however, it becomes probably the most effective teaching device known. Therefore, laboratory work should be planned so effectively that it will merit the expense involved.

Objectives

Laboratory work in pharmacology, like that in most fields, can either be complex and theoretical or simple and practical. In general, highly complex and esoteric experimental pharmacology should be reserved for graduate courses and has little relevance for the undergraduate laboratory. The objectives of a practical pharmacology laboratory and its relation to the practice of pharmacy have been described in the articles by Christensen (2), Dille (3), Hiner (4) and White (5). Many worthwhile suggestions will be found in these publications.

The nature and extent of the laboratory work in pharmacology is influenced by the objectives desired. Such objectives, when well chosen, apply not only to a laboratory work in pharmacology but also to any lecture-laboratory course. For convenience these objectives may be divided into three classes: (1) transformation and correlation of lecture material, (2) scientific reasoning, and (3) technic. A closer examination will reveal their special relation to pharmacology.

1. Transformation and correlation of lecture material. The primary objective of the pharmacology laboratory should be to explain, expand, clarify and dramatize the salient points covered in the lecture. The work should be planned to follow in logical sequence the theoretical material presented in lecture. All too frequently the lecture course is unrelated to the laboratory work.

By the time the average pharmacy student takes pharmacology, he has been drilled for two or three years in the preparation of drugs, the significance of incompatibles, and the organic synthesis of certain compounds, but not once has he seen a drug in action. The laboratory, therefore, becomes the place where the student can see for himself the biological effects produced by drugs. He can see how drugs modify normal or altered physiological processes. Experiments can be selected to show the rational basis for modern therapy. On occasion, they may even be designed to show that some of our currently employed drugs can no longer be considered valuable therapeutic agents and merit a deserved obsolescence.

In previous classes the student pharmacist has learned the doses and the forms in which drugs are administered. Beginning lectures in pharmacology usually give consideration to the factors which modify the dose of a drug. The laboratory should be used to show the influence of such factors as the weight of the animal, route of administration and the rate and channel of excretion on the therapeutic dose of a drug. In addition, a simple experiment showing the range between the effective and the toxic dose of a drug gives tangible meaning to the term "margin of safety." Studies on nephrectomized and hepatectomized animals illustrate how the organs of excretion and detoxification affect potency and duration of drug action.

An important aspect of any lecture course in pharmacology is a consideration of the toxic action produced by the injudicious use of therapeutic agents or by individual hyper-susceptibility to these compounds. On many occasions the practicing pharmacist is called upon to suggest first-aid treatment in acute accidental poisonings or to render an opinion as to proper antidotal procedures in therapeutic mishaps. An understanding of the mechanism by which various drugs produce their toxic effects enhances the student's understanding of the proper treatment which should be instituted. Therefore, some laboratory experiments should be designed to show the toxic effects of the more common agents, and the appropriate treatment of poisonings.

2. Scientific reasoning. It is well known that the rapid advances in the medical and the pharmaceutical sciences have markedly influenced the character of prescriptions now being written by physicians. Current prescriptions require little compounding skill on the part of the practitioner of pharmacy and in all probability will require even less in the future. This imposes new obligations upon those who train pharmacists and those who practice pharmacy. One obligation is that the pharmacist be trained as a professional man with a specialized knowledge of drugs. This training should be of such caliber that the pharmacist will be in a position to act as a source of drug information to practitioners of medicine. To do this the pharmacist must be curious and willing to keep abreast of new advances and able to read the trade literature intelligently, to reason scientifically and to use good judgment.

There is no guarantee that a student will learn to think more clearly by virtue of a laboratory course in pharmacology. However, if the laboratory is properly organized the student can learn to handle new ideas and material and can be stimulated to do much thinking for himself. In addition, he accurately records observations and correctly summarizes and interprets data, and under the guidance of a skilled instructor he can learn to draw conclusions on the basis of scientific reasoning. Wherever possible, experiments should be designed to develop such abilities.

3. Technics. Every science has technics and procedures which are peculiar to it. Few of the technics learned by the student in the pharmacology laboratory are essential for the compounding of a prescription. Nevertheless, they do contribute to the student's general professional background and to his understanding of the subject.

By actual experimentation he learns how to administer drugs to various animals. Such training will be especially valuable to him in a community where veterinary products are of economic importance. He learns the use and care of laboratory animals and equipment. He becomes proficient in the use of hypodermic syringes and needles and in the basic technics of parenteral injection. Likewise, he acquires some of the elementary technics used to demonstrate fundamental drug action.

Demonstrations and visual aids may be employed to show some of the more complicated experimental and clinical procedures. Carefully selected motion pictures will teach the student many things that cannot be presented in the laboratory, such as clinical cases and the responses of patients to medication.

If all three objectives discussed above are realized the pharmacy

student will have acquired a fundamental knowledge of pharmacology which will enable him to converse intelligently with the best physicians in his community. A major interest of the physician is drug therapy. The problems which he brings to the pharmacist often center on questions of new therapeutic agents, ways of dispensing drugs, dosage, and the actions and uses of drugs. The pharmacist should be trained to the point where he can contribute intelligently and be of real practical service to the physician in this common field which he shares with the medical profession. It is too much to expect the physician to view the pharmacist as a professional equal if the latter is not able to contribute and serve in the one science which is common to both professions.

Selection of Experiments

The problem of selecting experiments for the pharmacology laboratory is influenced not only by the objectives just discussed but also by several additional factors. Some of the more important factors are: (1) relative importance of the various groups of drugs, (2) teaching value of the experiment, (3) ease of student participation, (4) laboratory equipment and personnel, and (5) animal supply.

1. Relative importance of various groups of drugs. The problem of selecting experiments dealing with the important drugs is of major significance. It involves not only the question of the relative importance of U.S.P., N.F., and N.N.R. drugs and specialties, but also the question of how much time should be allocated to each group. This question of time can be resolved in a measure by following the recommendations of the Pharmaceutical Survey that each college of pharmacy periodically study the current prescriptions written in the area served by the institution (6). The findings of such a survey delineate the obligations involved upon those who train pharmacists and for those who practice pharmacy. The fulfillment of these obligations requires that therapeutic advances be kept in mind when selecting experiments in order to avoid serious gaps in the current body of knowledge which should be imparted to students. The University of Utah College of Pharmacy is currently conducting such a state-wide prescription study. Preliminary results show that U.S.P. drugs account for 23.1 per cent, N.F. drugs 1.5 per cent and specialties for the remaining 75.4 per cent of all prescription items. Thirteen drug groups account for 86.7 per cent of the items dispensed. These groups and their contribution to the total number of prescriptions analyzed are shown in the following table.

The Pharmacological Classification of Prescriptions
in Utah
(January to April 1951)

Drug Group		Per Cent of Prescriptions
Analgesics		5.0
Antihistaminics		5.8
Anti-infectives		36.9
Antibiotics	18.5	
Sulfonamides	9.3	
Misc.	9.1	
Antispasmodics		2.3
Cardiovascular Agents		3.3

Drug Group	Per Cent of Prescription
Central Stimulants	3.4
Expectorants	2.6
Gastro-intestinal Agents	1.8
Hematinics	3.8
Hormones	2.0
Inhalants	4.0
Vitamins	7.5
Sedatives and Hypnotics	8.4
Miscellaneous Agents	
Anticonvulsants	13.2
Antinauseants	
Antirheumatics	

The above table indicates those groups which presumably should receive major emphasis. The details of this study indicate the relative importance of the principal drugs in each classification, as measured by the current prescription writing activity of physicians in the State. It should be remembered that other groups of drugs, such as general anesthetics, local anesthetics, antiseptics, and parenteral fluids are extensively used in the practice of medicine although they are not common prescription items. Most certainly such information is useful not only as a basis for selecting experiments for laboratory work in pharmacology but also as a basis for selecting lecture material. A word of caution is necessary. Slavish adherence to the results of such surveys as that just mentioned will certainly mean that the instructor will accept as valid therapeutic agents many items of questionable value being sold in quantity merely because of current fads and misleading advertising.

2. Teaching value of the experiment. Consideration should be given to the teaching value of each experiment. The simpler an experiment, the better. To be of most value an experiment should be designed to show clearly only a few mechanisms or phenomena at a time. However, even the most dramatic experiment will fail as a teaching tool if an astute instructor is not present to pursue the various implications and ramifications of the experimental results.

3. Ease of student participation. Certain experiments should also be selected on the basis of ease of student participation. In general, experiments which permit student groups to work on various aspects of a single problem are most useful. In this type of experiment the results of the various student groups are correlated to show the final over-all result. Such a procedure also permits the multiple data to be used as an introduction to elementary statistical procedures.

4. Laboratory equipment and personnel. Limited equipment is not a valid reason for omitting laboratory work in pharmacology. Equipment for this course is no more expensive than for other basic sciences in the curriculum. With a little ingenuity an instructor can devise many worthwhile experiments with a minimum budget. It should be emphasized that it is not extensive "plumbing" and expensive "gadgets" that makes a successful pharmacology experiment, but it is the presence of a good instructor to stimulate the student and to assure that the laboratory observations are correctly interpreted. Special research interests being pursued by members of the staff sometimes provide unusual equipment and technic for

simple informative and dramatic experiments or demonstrations. These experiments often prove to be the most valuable of all teaching aids. In view of these facts it is obvious that the range of experiments will vary in each institution according to the equipment and the budget available to pharmacology, and the training and availability of competent personnel.

5. Animal supply. Many students approach the pharmacology laboratory with mixed feelings. They have weird ideas concerning the type of experiments and the extent of surgery required in this course. The average pharmacy student has neither the training nor the technic to perform extensive surgery. Therefore, the majority of student experiments should be done on intact animals or require only a minimum of surgery. In addition, each institution has its own problems concerning the procurement of animals. For example, at our institution it would be very unwise to enter into competition for an already inadequate supply of dogs and cats. In view of these facts, dogs and cats are used only for an occasional demonstration and the rabbit, guinea pig, rat, mouse and frog are used for student experiments. It is of utmost importance that the student learn to respect the welfare of the experimental animal. Animals should be treated kindly and spared all discomfort possible during the course of the experiments. Failure to observe the proper care and humane handling of experimental animals is a major offense and should exclude the offender from further participation in the course.

Hours and Credits

The 1942 Syllabus (7) recommended that 80 clock hours be devoted to laboratory work in pharmacology, including bioassay. This would be approximately one three-hour laboratory session per week for one year. The Curriculum Committee (8) recommended 3 credit-hours for each of two semesters with no suggestions relative to the time spent in the laboratory. The Pharmaceutical Survey (6) recommends a total of 24 semester-hours of credit in pharmacology and related sciences without specific recommendations as to how it is to be used. However, if laboratory work is recognized as a useful and important teaching discipline, then this type of instruction should be carried on during the entire course in pharmacology. Therefore, an ideal arrangement would appear to be 3 hours of laboratory work and 3 hours of lecture each week for one academic year. It is on this basis that the following syllabus is suggested.

Syllabus

This outline is not intended to be complete but is designed mainly to list typical experiments which the author has found of value in teaching pharmacology to pharmacy students. Likewise, it should not be implied that the motion pictures listed are the only ones considered of value. The ones included in the outline are merely examples of motion pictures which have been found to be suitable teaching aids. No attempt has been made to differentiate between demonstrations and student experiments. It is recognized that the proportion of time devoted to each will vary according to the ability of the instructor, available equipment and animals, and other factors. Finally, it should be emphasized that the outline is not final and should constantly be revised in keeping with changing therapeutic trends and with the development of new pharmacological technics and agents.

I. METHODS OF GENERAL PHARMACOLOGY

A. Drug Administration.

1. Experiments.

a. General Technic of Handling, Weighing and Injecting Animals

In this experiment the various procedures for handling, weighing, and injecting animals are demonstrated and the students practice the technics in rats.

b. Effect of the Route of Administration on the Action of Fixed Anesthetics

This experiment is designed to show how the route of administration affects onset and duration of action of sodium pentobarbital in rats.

2. Motion Pictures

a. Conservation of Syringes and Needles

One reel; color; 30 minutes. This motion picture clearly illustrates the manufacture and proper care of hypodermic syringes and needles. Courtesy Becton, Dickinson and Company.

b. Technics of Injection

One reel; color; 20 minutes. Demonstrates the procedure for intradermal, hypodermic, intramuscular and intravenous injection. Courtesy Becton, Dickinson and Company.

B. Distribution and Fate of Drugs

1. Experiment.

a. Absorption and Excretion of Drugs by Man

This experiment is intended to show that considerable variation exists in the rate of excretion of drugs (potassium iodide, sodium salicylate, quinine, etc.) in saliva and urine; also demonstrates the effect of pH upon the absorption and fate of methenamine.

C. Variations in Response to Drugs

1. Experiment.

a. Individual Variations in Response to Sodium Pentobarbital Injections

This experiment illustrates the individual variation to a fixed dose of sodium phenobarbital in mice. A distribution curve is constructed and its relationship to individual sensitivity discussed.

D. General Toxicology

1. Experiments.

a. Acute Carbon Monoxide Poisoning

b. Acute Cyanide Poisoning

c. Nicotine Poisoning

d. Strychnine Poisoning

These experiments are designed to show the general symptoms and treatment of poisoning due to these agents.

In the case of strychnine, the site of action is localized.

II. PHARMACOLOGY OF THE CENTRAL NERVOUS SYSTEM.

A. General Anesthetics.

1. Experiments.

a. The Relation Between Concentration and Effect of Inhaled Anesthetics

This experiment shows that the intensity of pharmacological action is dependent, among other things, upon the concentration of drug.

b. Demonstration of Distribution Coefficient

This is the classical demonstration illustrating the quantitative relation between narcotic strength and lipid affinity.

2. Motion Pictures.

a. The Advent of Anesthetic Ether

One reel; sound; 12 minutes. A re-enactment of the first publicized demonstration of ether anesthesia in the old Massachusetts General Hospital.

b. Signs of Inhalation Anesthesia

Two reels; 25 minutes. Presents good illustrations of stages and planes of anesthesia. Obtained from the American Medical Association.

c. Vinethene

Color; 12 minutes. This film shows the performance of several short operations under Vinethene anesthesia and its use as an induction agent prior to ether. Courtesy of Merck and Company.

B. Hypnotics and Sedatives

1. Experiment.

a. The Fixed Anesthetics and Hypnotics

This is a comparative study in rats of typical drugs used as fixed anesthetics.

2. Motion Picture.

a. Chronic Barbiturate Intoxication

One reel; color with commentary; 30 minutes. This film shows the effect of the chronic administration of pentobarbital and amytal in man. The acute disturbances following withdrawal of barbiturates are clearly shown. Courtesy Dr. Harris Isbell, Public Health Service Hospital, Lexington, Kentucky.

C. Antiepileptics

1. Experiment.

a. Assay of Antiepileptic Drugs

Anticonvulsant activity of diphenylhydantoin and trimethadione is demonstrated by two of the most useful assay procedures. The data obtained permit an introduction to biological statistics.

In the case of strychnine, the site of action is
localized.

II. PHARMACOLOGY OF THE CENTRAL NERVOUS SYSTEM.

A. General Anesthetics.

1. Experiments.

a. The Relation Between Concentration and Effects of Inhaled Anesthetics

This experiment shows that the intensity of pharmacological action is dependent, among other things, upon the concentration of drug.

b. Demonstration of Quantitative Coefficient

This is the classical demonstration illustrating the quantitative relation between narcotic strength and lipid affinity.

2. Motion Pictures.

a. The Advent of Anesthetic Ether

One reel; sound; 12 minutes. A re-enactment of the first published demonstration of ether anesthesia in the old Massachusetts General Hospital.

b. Stages of Inhalation Anesthesia

Two reels; 25 minutes. Presents good illustrations of stages and planes of anesthesia. Obtained from the American Medical Association.

c. Ilostone

Color; 12 minutes. This film shows the performance of several short operations under Vinethene anesthesia and its use as an induction agent prior to other. Courtesy of Merck and Company.

B. Hypnotics and Sedatives

1. Experiments.

a. The Fixed Anesthetic and Hypnotics

This is a comparative study in rats of typical drugs used as fixed anesthetics.

2. Motion Pictures.

a. Chronic Barbiturate Intoxication

One reel; color with commentary; 30 minutes. This film shows the effect of the chronic administration of pentobarbital and acetal in man. The acute disturbances following withdrawal of barbiturates are clearly shown. Courtesy Dr. Nerris Isbell, Public Health Service Hospital, Lexington, Kentucky.

C. Antipyretics

1. Experiment.

a. Assay of Antipyretic Drugs

Antipyretic activity of diphenylhydantoin and trimethadione is demonstrated by two of the most useful assay procedures. The data obtained permit an introduction to biological statistics.

D. Analgesics

1. Experiments.

a. Measurement of Analgesic Activity in Man.

Analgesic potency of morphine and codeine is determined by the Hardy-Wolff-Goodell pain threshold apparatus.

b. Effect of Acetanilid on Pain Threshold of the Rat.

Analgesic potency is measured by the rat-tail, radiant-heat method.

c. Special Biological Test for Morphine (Straub and Hermann).

This illustrates the characteristic S-shaped curvature of the tail produced by morphine. It may also be an assay for curare.

2. Motion Picture.

a. Opiate Addiction.

One reel; black and white; silent; 20 minutes. This film shows the addictive and withdrawal symptoms of morphine, codeine and Dilaudid on the monkey. Courtesy Bilhuber-Knoll Corp.

E. Central Stimulants

1. Experiments.

a. The Effects of Metrazol

This experiment demonstrates the characteristic convulsions produced by metrazol and the antagonistic effect of pentobarbital.

2. Motion Pictures.

a. Coramine.

One reel; color; sound; 45 minutes. Includes animations showing mechanisms of respiratory stimulation, apparatus for measuring accumulated tidal volume and methods for optical registration of intrathoracic, vascular and intra-abdominal pressure. Courtesy Ciba Company.

b. Pharmacological Study of Metrazol.

One reel; color; sound; 50 minutes. Includes demonstration of analeptic action and effects on respiratory and circulatory systems under ordinary laboratory conditions. Courtesy Bilhuber-Knoll Corp.

III. PHARMACOLOGY OF THE AUTONOMIC SYSTEM

1. Experiments.

a. Effects of Autonomic Drugs on the Isolated Frog's Heart

This experiment shows the effect of epinephrine on the rate and amplitude of the isolated heart beat and demonstrates how the rate change can be used to measure adrenergic blockade.

b. Effects of Autonomic Drugs on Circulation

Demonstrates the action of various drugs upon the autonomic nervous system as indicated by blood pressure

response.

c. Effects of Autonomic Drugs on Intestinal and Gastric Motility
Shows the effects of epinephrine, pilocarpine, atropine sulfate, prostigmine, carbachol, and barium chloride on gastro-intestinal motility.

d. Miotics and Mydriatics
The pupillary response of various miotic and mydriatic agents is measured in the rabbit.

2. Motion Picture.
a. Mecholyl Chloride Administered by Ion Transfer
One reel; color; 12 minutes. Illustrates the method for administration of methacholine chloride by means of the galvanic current and shows the result in a case of chronic ulcer and in a case of scleroderma. Courtesy Merck and Company, Inc.

IV. THE PHARMACOLOGY OF LOCAL ANESTHETICS
1. Experiments.
a. Local Anesthesia in Man
The absence and recurrence of sensitivity to pain is determined following the intracutaneous injection of procaine hydrochloride with and without epinephrine.

b. Measurement of Local Anesthesia in the Frog
A comparative study of the local effects of butacaine and procaine upon reflex time in frogs.

2. Motion Picture.
a. Regional Anesthesia
Four reels; color; 50 minutes. This film depicts abdominal block, spinal anesthesia, sacral plexus block, cervical plexus block, brachial plexus block, and ulnar and median nerve block in man. Anatomical illustrations and reproductions of special models are employed to show the path of the needles used in inducing anesthesia of the various regions. Several types of actual operative procedures are shown. Courtesy of Winthrop Chemical Company, Inc.

V. PHARMACOLOGY OF HISTAMINE AND ANTIHISTAMINICS
1. Experiments.
a. Experimental Bronchial Asthma Due to Atomized Histamine
Shows the protective effect of pyribenzamine in a guinea pig exposed to atomized histamine.

b. Antihistaminics in the Prevention of Anaphylactic Shock
Demonstrates the protective action of antihistaminics against a shocking dose of horse serum in guinea pigs.

2. Motion Picture.
a. Allergies
One reel; sound; color; 45 minutes. Describes the histamine theory of allergic reaction and the mechanism of action and use of antihistaminics (neohetramine) in treating allergic manifestations. Courtesy Wyeth Company.

VI. PHARMACOLOGY OF THE UTERUS

1. Experiments.

a. Influence of Drugs on the Activity of the Isolated Uterus

Demonstrates the method of recording normal uterine activity and its alteration by the common agents.

VII. PHARMACOLOGY OF THE HEART AND CIRCULATION

1. Experiments.

a. Effects of Digitalis on the Frog Heart

Designed to show that the effect of digitalis on the intact heart varies with the concentration.

b. Determination of Normal Blood Pressure and Effects of Epinephrine, Pitressin, Amyl Nitrite and Chloroform

Emergency treatment of shock and hypertensive states frequently require the use of an agent to alter blood pressure. This experiment shows the effect of several commonly used agents on blood pressure in rats. The blood pressure may be determined by direct carotid cannulation or indirectly by means of a photo-electric tensiometer.

2. Motion Pictures.

a. Management of the Failing Heart

One reel; color; sound; 35 minutes. Impairment of heart function due to auricular fibrillation, constrictive pericarditis and pericardial effusion and effects on respiratory system are shown. The management of the patient in heart failure shows the value of properly instituted bed rest and how salt restriction maintains the proper extracellular fluid balance to reduce edema. Effects of mercurial diuretic and "Digitaline Nativelle" are evaluated. Courtesy Varick Pharmacal Company.

b. Cardiac Arrhythmias

One reel; color; 18 minutes. Graphically illustrates various cardiac arrhythmias and correlates them with the electrocardiogram. Courtesy Abbott Laboratories.

c. Mechanism of the Heart Beat

One reel; silent; black and white; 20 minutes. This film, by animated diagrams, describes the anatomy and nervous control of the heart with simultaneous analysis of the normal electrocardiogram. Courtesy Bilhuber-Knoll Corp.

VIII. PHARMACOLOGY OF DIURETICS AND ANTIDIURETICS

1. Experiment.

a. Diuretics and Antidiuretics

This experiment shows the effect of water, 0.9% sodium chloride solution, posterior pituitary, intraperitoneal glucose solution and mercurial diuretics on urine excretion in rats.

IX. PHARMACOLOGY OF CATHARTICS

1. Experiments.

a. Effect of Hypotonic, Isotonic, and Hypertonic Solutions on Gastro-intestinal Contents

Demonstrates the osmotic properties of various ions and how they affect the bulk and character of the stool.

X. PHARMACOLOGY OF THE BLOOD

1. Experiments.

a. Effect of Heparin and Dicumarol on Blood Coagulation and Prothrombin Time

This experiment demonstrates the action of these agents on the blood of rats by determination of coagulation and prothrombin time.

b. Effect of Phenylhydrazine on Red Blood Cell Count and Hemoglobin Determinations

This experiment is used to illustrate how some agents alter the blood.

2. Motion Picture.

a. Animated Hematology

One reel; silent; color; 45 minutes. Excellent film describing the physiology of the hemopoietic principle and the various diseases caused by an insufficient number or malfunction of the erythrocytes. Courtesy of Armour Laboratories.

XI. ANTI-INFECTIVES

A. Antisyphilitics

1. Experiment.

a. The Effect of Organic Arsenicals on the Motility of Trypanosomes and on Experimental Trypanosoma equiperdum Infections in Rats

The chemotherapeutic effect of oxophenarsine hydrochloride is demonstrated in rats.

B. Antibiotics

1. Experiments.

a. Assay of Antibiotics

Penicillin is assayed by the disk method.

b. An Antibiotic With a Wide Range Antimicrobial Spectrum

The broad spectrum of aureomycin is shown by culturing sputum with various concentrations of the antibiotic.

2. Motion Picture.

a. Aureomycin

One reel; color; 45 minutes. This film shows the method of isolation, testing and determination of antibiotic spectrum. Courtesy Lederle Laboratories.

C. Sulfonamides

1. Motion Picture.

a. Sulfonamide Therapy

Three reels; color; 45 minutes. The story of sulfonamides from the synthesis in 1908 to the present. Includes chemical synthesis, formulas, crystalline appearance, mode of action, excretion, toxicity, and clinical use. Courtesy Lederle Laboratories.

XII. PHARMACOLOGY OF DRUGS OF ENDOCRINE ORIGIN

1. Experiments.

a. Effect of Thyroid and Antithyroid Agents on Metabolic Rate
The metabolic rates of rats receiving thyroid and propylthiouracil are compared with that of normal rats.

b. Characteristics of Insulin Convulsions and Their Control
This experiment illustrates the character of insulin convulsions in mice. A comparative study of the efficacy of various agents in controlling insulin convulsions is conducted.

2. Motion Pictures.

a. The Male Sex Hormones
One reel; color; sound; 20 minutes. Shows the origin of the male sex hormone, its metabolic effects, the deficiency state, and the effects of exogenous male sex hormone in a variety of clinical conditions. Courtesy Schering Corporation.

b. The Physiology of Normal Menstruation
One reel; color; sound; 22 minutes. Presents the basic physiology necessary for the intelligent understanding of the pharmacology of female hormones. Courtesy Schering Corporation.

c. Hypothyroidism
One reel; sound; color; 48 minutes. The essential clinical entities of hypothyroidism such as cretinism, juvenile, adult and pituitary myxedema are dealt with in great detail, with typical patients shown. Effect on the metabolism is depicted pharmacologically and clinically. The recommended therapy to restore patient to normal is analyzed thoroughly. Courtesy Medical Film Guild.

XIII. PHARMACOLOGY OF THE VITAMINS

1. Motion Picture.

a. Vitamins--And Some Deficiency Diseases
Three reels; color; sound; 45 minutes. This film is presented in two sections, one dealing with vitamins A, C, D, E, and K, and the other with the vitamin B complex. The laboratory scenes cover deficiencies in experimental animals and biological and chemical methods of assay. Clinical deficiencies shown include cheilosis, scurvy, rickets, pellagra, and vitamin K deficiency. Courtesy Lederle Laboratories.

XIV. PHARMACOLOGY OF THE SKIN AND MUCOUS MEMBRANES

1. Experiments.

a. Effect of Agents on the Skin and Mucous Membranes
This experiment is intended to show the characteristic effect of corrosives and irritants on skin, hair and connective tissue.

2. Motion Pictures.

a. Skin Antiseptics
One reel; sound; black and white; 20 minutes. A presentation of the various types of comparative tests which

are used for the evaluation of antiseptics. Tincture of iodine is compared with three organic mercury antiseptics. Results frankly favor the use of iodine. Courtesy Iodine Educational Bureau, Inc., N. Y.

Laboratory Aids

Demonstrations. The demonstration method of teaching pharmacy students in the pharmacology laboratory has been advocated by some teachers,--in preference to student experiments,--on the basis that it allows the student to concentrate on the purpose and results of the experiment, that it requires less equipment and that it permits more effective use of the time available. If a valuable experiment requires apparatus and technics so complex that the major part of the student's time is needed to master them, it is perhaps better for the instructor to demonstrate it. On the other hand, if the experimental procedure is simple and well adapted to student use, even limited equipment is not a valid reason for a demonstration rather than a student experiment, because the student groups can be rotated. Student experiments require little if any more time than demonstrations. An important limiting factor in favor of demonstrations is that of availability of animals,--especially dogs and cats,--for student experiments. Although the demonstration method is most useful for those experiments requiring larger animals and/or complex apparatus, student participation is a far better method of teaching.

Examinations. Periodic examinations should be an integral part of a well-planned laboratory course in pharmacology. The laboratory work assumes greater importance if the student knows he is going to be examined specifically on material covered in the laboratory. In addition to its pedagogic value, the laboratory examination provides an additional index for student evaluation and indicates to the instructor the effectiveness of his laboratory teaching.

Examinations may take a myriad of forms, the discussion of which is beyond the scope of this presentation. The author prefers those examinations which tests the student's ability to apply fundamental principles learned in the laboratory to novel situations.

Laboratory Manuals. There are many factors which influence the selection of experiments in pharmacology. As a result most instructors prefer to prepare their own laboratory manuals. The advantage of such a procedure is two-fold. First, the experiments can be designed to secure maximum use of available equipment. Second, it permits greater flexibility and encourages the instructor to constantly revise the manual as new technics and new therapeutic agents appear. Although most manuals have been published primarily for use at an author's institution, several have found acceptance in other schools.

Library. In view of the rapid advances in the field of pharmacology and therapeutics, students should be encouraged to read regularly the current journals. The library references pertinent to each experiment should be listed. The student should then read these references as a required portion of the laboratory work. Such reading will not only provide a greater appreciation and understanding of the technics employed in the pharmacology laboratory, but will also emphasize the importance of reading the current periodicals in order to keep up with this dynamic subject.

Motion Pictures. Many motion picture films have been prepared for teaching pharmacology and also for the medical profession. Unfortunately, many of the films prepared for pharmacology are not available on a loan basis. On the other hand, many of the films are prepared specifically for the medical profession and are not entirely suitable for or pertinent to pharmacology. It is therefore necessary to select films carefully on the basis of their direct application to pharmacology and the practice of pharmacy.

How much time should be devoted to motion pictures and should they ever be used to replace experiments or demonstrations? Certainly the student should see for himself the action of a considerable number of drugs in experimental animals and should become acquainted with the more common experimental technics. On the other hand, carefully selected motion pictures will show the student many things that cannot be presented in the laboratory, such as clinical cases and the response of patients to medication. Students should be prepared before the motion picture is presented either by their reading of pamphlets provided by the distributor of the film or by a review of the salient points by the instructor.

Summary

In summary, it may be stated that pharmacology is of major importance in the pharmacy curriculum. It is also recognized that laboratory work is one of the most effective methods of teaching. Therefore, laboratory work should be an integral part of the undergraduate course in pharmacology. The objectives of this laboratory course should be to transform and correlate the lecture material in a logical sequence, to develop scientific reasoning, and to provide an opportunity to learn technic. The laboratory work should be flexible and constantly revised to include the new agents of therapeutic value. Experiments should also be selected on the basis of the teaching value, ease of student participation, available laboratory equipment, and animal supply. A selected list of experiments and motion pictures which have been found useful in teaching pharmacology to pharmacy students has been reviewed. Laboratory aids, such as demonstrations, examinations, laboratory manuals, the library, and motion pictures, should be integrated with student experiments. Finally, the pharmacist should be trained in pharmacology to the point where he can contribute intelligently and be of real practical service to the other health professions. It is too much to expect practitioners in the other health sciences to view the pharmacist as an equal if he is not properly trained in the very science which is fundamental to his profession.

References

1. Swinyard, Ewart A., Unpublished research.

2. Christensen, B. V., The Method of Laboratory Work in Pharmacology. Am. J. Pharm. Ed., 3, 65-68, 1939.

3. Dille, J. M., The Nature of Laboratory Work in Pharmacology for Pharmacy Students. Am. J. Pharm. Ed., 3, 72-78, 1939.

4. Hiner, L. D., The Aims and Objectives of the Course in Pharmacology and How to Obtain Them. Am. J. Pharm. Ed., 4, 203-207, 1940.

5. White, W. F., What Should Be Included in a Laboratory Course in Pharmacology, Toxicology and Physiology, Am. J. Pharm. Ed., 5, 209-212, 1941.

6. Findings and Recommendations of the Pharmaceutical Survey, pp. 34-36, American Council on Education, Washington, D. C., 1949.

7. The Pharmaceutical Syllabus, Fifth Edition (tentative), pp. 141-146. The National Pharmaceutical Syllabus Committee, 1942.

8. Webster, J. L., Report of the Committee on Curriculum. Am. J. Pharm. Ed., 12, 765-782, 1948.

References

1. Unpublished research.

2. Unpublished research.

3. Unpublished research.

4. Unpublished research.

5. Unpublished research.

6. Unpublished research.

7. Unpublished research.

8. Unpublished research.

PHYSICAL REQUIREMENTS FOR PHARMACOLOGICAL INSTRUCTION

John W. Nelson
College of Pharmacy, Ohio State University
Columbus, Ohio

Relatively few pharmacy schools have pharmacology laboratories in operation yet. This is so for a variety of reasons. The pharmacology department is undoubtedly the most difficult to plan, acquire, equip and maintain. An additional deterrent is that it requires a considerable financial layout to equip and to operate. Too many of those that are said to be in operation are improvised, make-shift, and inadequate. The poorly equipped laboratory is as worthless as the poorly operated laboratory, and the poorly operated laboratory is worse than no laboratory at all. The poorly planned laboratory might be satisfactorily operated, but it requires an excessive expenditure of effort. Therefore, it is impossible to devote too much effort to planning, and while it is improbable that anyone can have sufficient foresight to plan for all future needs, intelligent and guided planning will at least result in a department which in capable hands will be able to meet the objectives of pharmacology in the pharmacy curriculum. Many schools are at the present time planning their pharmacology departments and it is hoped that the presentation of these ideas here at the Seminar may serve as a guide to these and future planners of pharmacology departments.

From the nature of the many inquiries and requests for information that I have received in the past year, I can see that many of the planners are attacking the problem backwards. They are deans or other administrators (with no pharmacology experience) who have not yet procured the pharmacologists who will teach the courses, but they are optimistic enough to believe that they will find someone. Desiring to have the physical facilities available for him, they are planning and equipping rooms for pharmacology. This procedure is very hazardous if these deans do not procure expert advice from pharmacologists. They have the "cart before the horse" and at best this procedure should be followed only up to the point of providing the minimum essentials. A more logical and better procedure is to first plan the course and design the experiments--and then equip the department.

For those who have no concept of the physical requirements for pharmacology, these ideas and plans should be revealing; for those who think they know these requirements they should be either verifying or instructive.

These planners can be divided into two groups: the fortunate (and envied) few who can plan their departments before the building is built, and the larger group who must take available rooms which were built for other purposes and make them over to suit their needs as best they can. The plans presented here--with necessary modification--should be equally useful to both groups.

The first questions to be answered are "what purpose is the laboratory to serve?" and "what are the particular needs of the laboratory to serve that purpose?". "Is it to serve as a teaching laboratory for undergraduate instruction only, or is it to serve as a research laboratory, or must it serve as both?" The ideal research laboratory is not neces-

sarily a good laboratory for the teaching of fundamental pharmacology and vice versa.

The ideal physical requirements for a pharmacology department are obviously a matter of opinion. What might be considered ideal by one individual may be, in the opinion of another, decidedly inadequate. The ideas being presented in this paper are not to be regarded as the ideal, but rather a presentation of workable plans for a satisfactory pharmacology department.

The essential component parts of a pharmacology department are: (1) Office for each member of staff, (2) Laboratories for teaching and research, (3) Animal rooms, (4) Work shop. The space assigned to each of these areas and the elaboration of facilities of each is largely determined by the size of the school. As a guide to how these areas may be modified in different size schools, plans are presented for a relatively small school (24 students per class) and a relatively large school (100 students per class).

Office Space

Little needs to be said regarding this part of the department other than to suggest that the location should be adjacent or at least convenient to the laboratories and especially to recommend that each office be provided with adequate work space for individual research. The number of offices should be determined by the number of staff members, both on hand and anticipated for the future.

The idea of an individual office for each major staff member is not universally accepted, but I believe it is very desirable. There are not too many compensations for being a college professor, and it seems that the least the school can do is to provide a private working room for him where he can be a "king for the moment." Because of the freedom it affords for private conferences with students, the chance to work with a minimum of interruptions, and the opportunity to plan his work day limited only by his personal schedule, he will be a better and more efficient teacher.

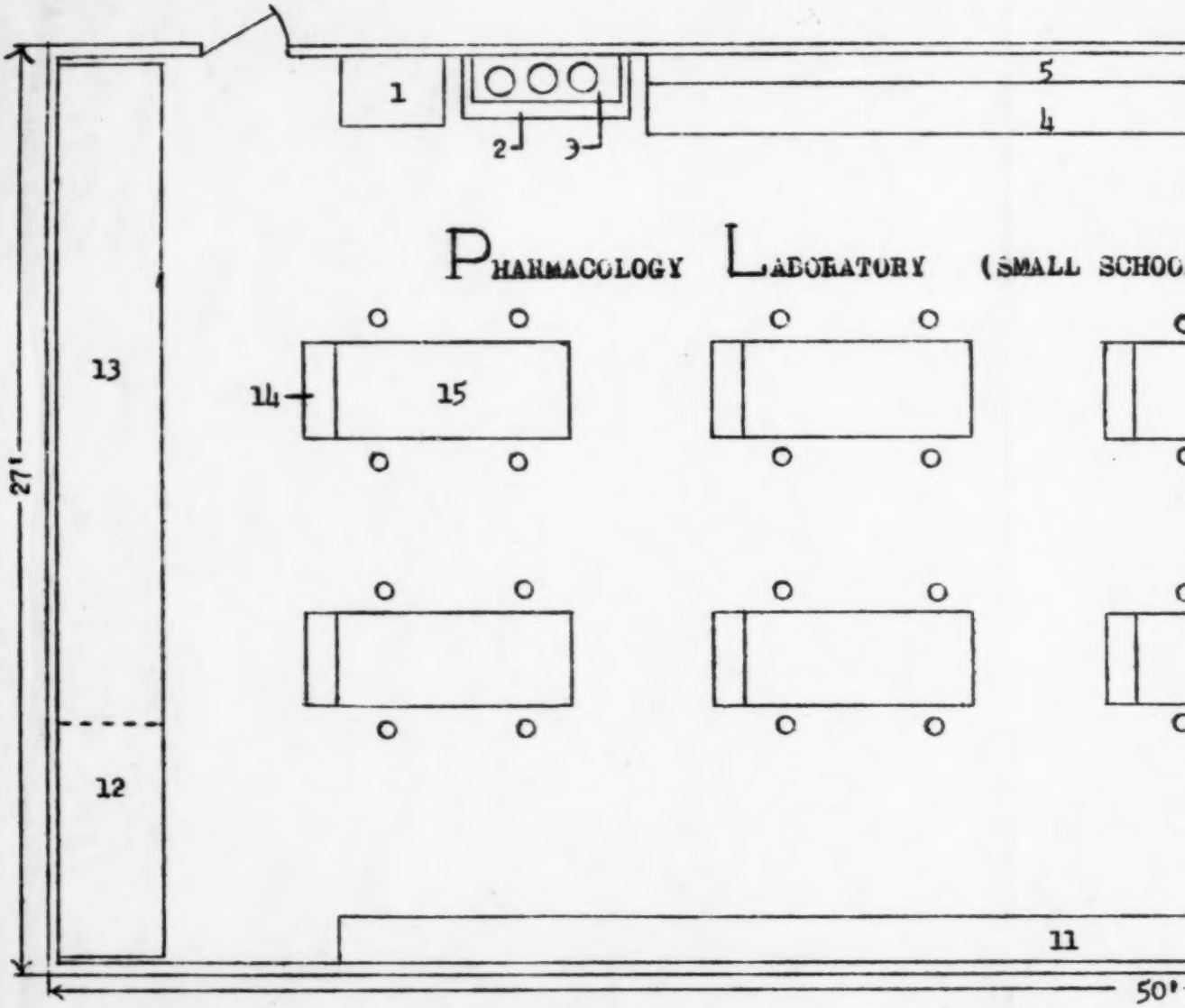
Any teacher worthy of the name wants to carry on some research. Facilities should be provided to encourage the carrying out of such desires.

Offices should be so located that the department can be properly supervised and records, files, and books are available for reference.

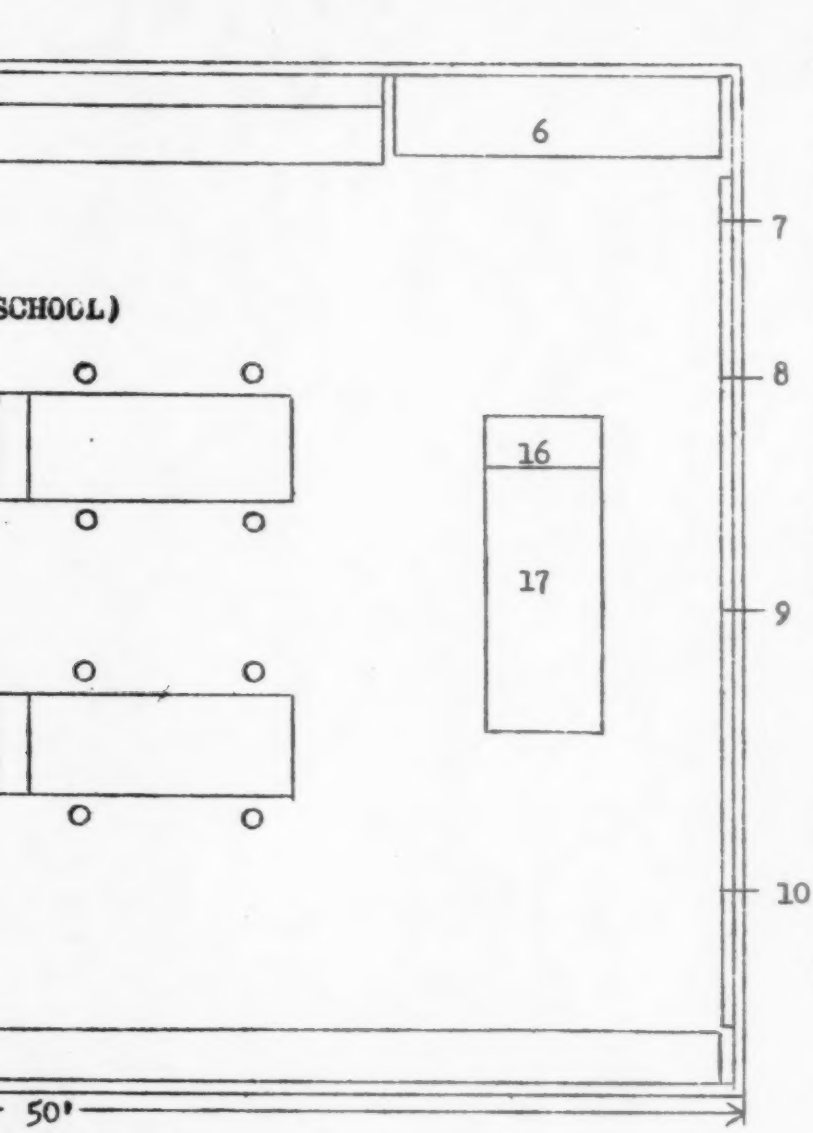
Laboratory

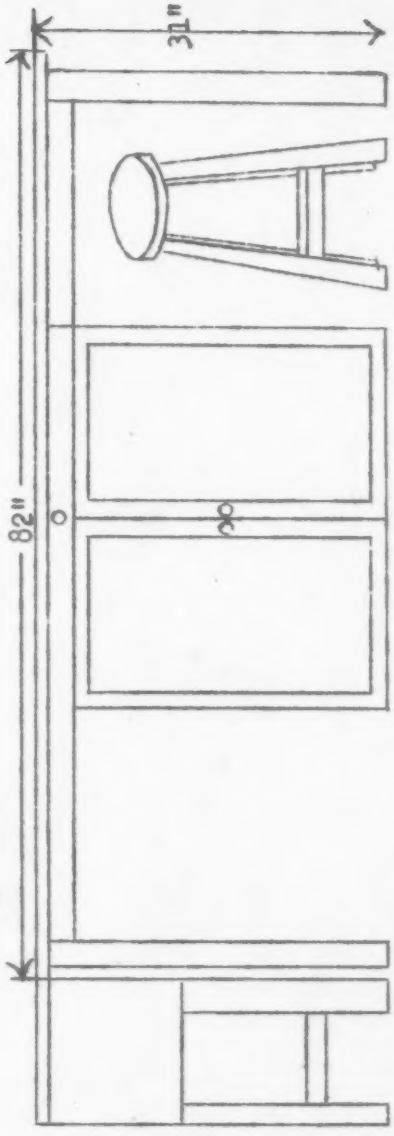
The requirements of the laboratory for the small or the large school are essentially the same. The requirements do not vary as much as might be expected. The large class must be divided and because of the close individual supervision necessary in pharmacological work, I have found it impossible to properly handle classes of larger than six to eight groups (four students per group).

While two plans are presented here--one labeled for the large school and one for the small school--they are suggested more for the cases where space is or is not a factor. The one suggested for the large school is



1. Refrigerator
2. Sink
3. Heavy duty shelf with carboys of P.S.S. etc.
4. Work Table
5. Reagent Shelves
6. Smoking and Shellacking
7. Charts
8. Blackboard
9. Projection Scree
10. Blackboard
11. Cabinets



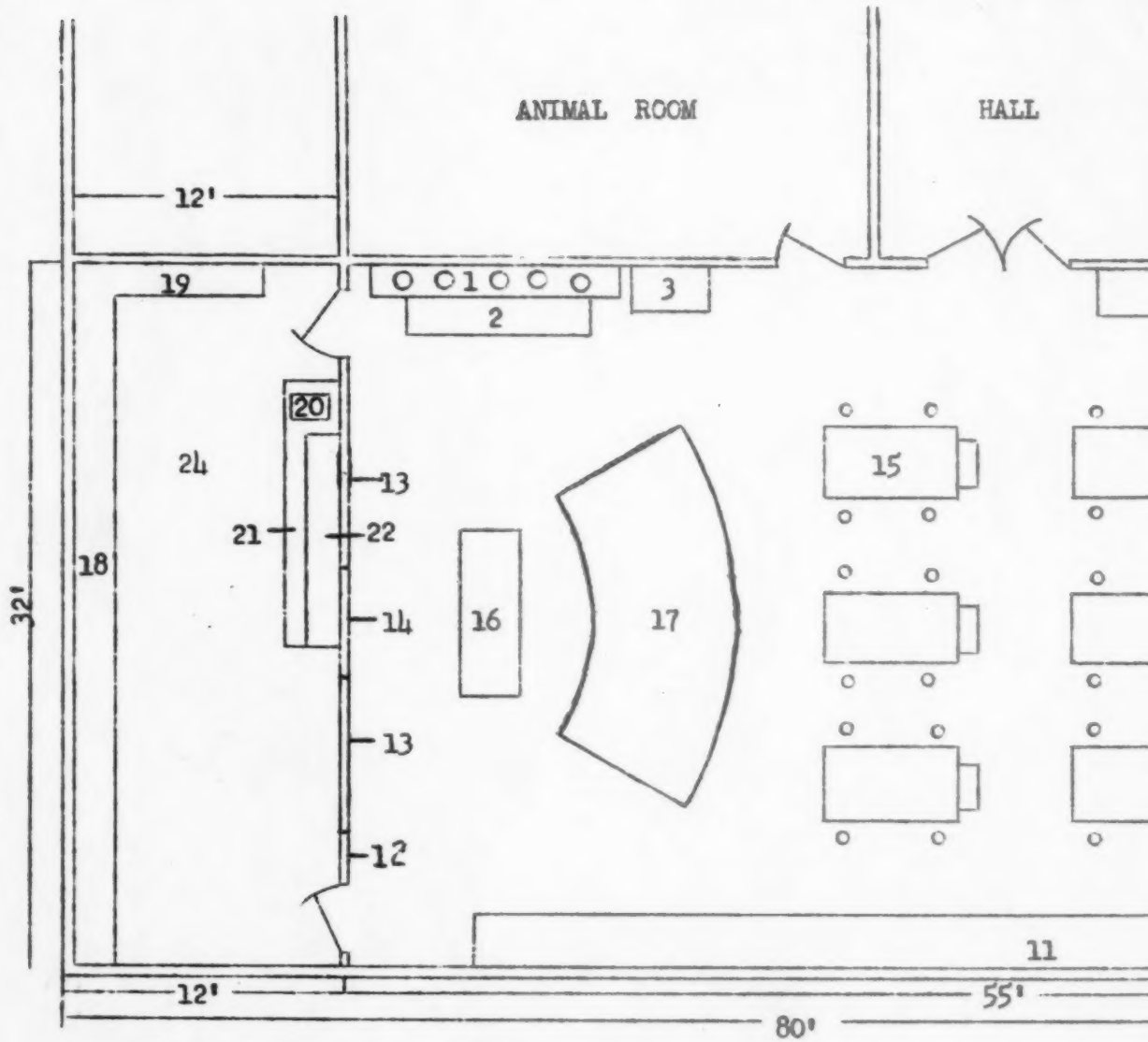


12. Shop Work
Screen 13. Work Table
14. Sink
15. Lab Desk
16. Sink

5 Ft.

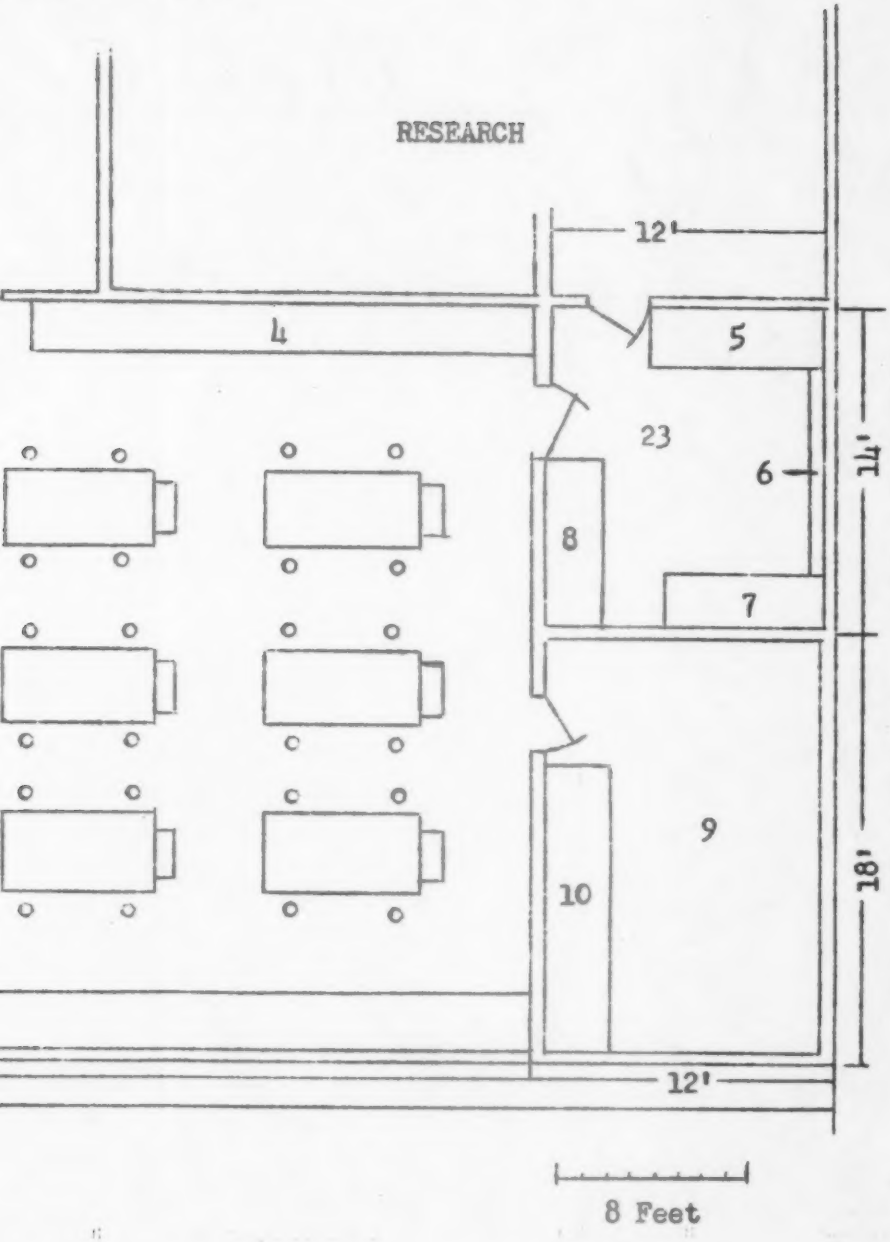
AREA - 1350 Square Feet.

PHARMACOLOGY LABORATORY (LARG



AREA		
	Lab:	1760 Sq. Ft.
	Work Shop:	216 " "
	Storage:	384 " "
	Kymograph:	148 " "

(LARGE SCHOOL)



1. Heavy duty shelf for carboys of P.S [illegible]. etc.
2. Sink
3. Refrigerator
4. Enclosed cabinets
5. Work table
6. Racks for drying shellacked records
7. Shellack
8. Smoking area
9. Work shop
10. A work bench
11. A work table
12. Charts
13. Blackboards
14. Projection screen
15. Group desks
16. Demonstration desk
17. Chairs for lecture and/or demonstration
18. Open storage shelves in the storage room
19. Drug storage
20. Sink
21. Preparation table with
22. Reagent shelves above it.
23. Kymograph Room
24. Storage Room

the desirable one for both schools, whereas the other might be considered a minimum, but workable plan, necessitated by space limitations.

A tremendous space-saver is the plan whereby only equipment which is constantly used is fixed into position and most equipment which is used only occasionally is stored. Large equipment seldom used can be mounted on portable tables which can be moved into place when needed. Therefore, a suitable storage room saves many times over the space area it requires.

It is impossible to have too many cabinets and shelves for storage. These should be enclosed and lockable. It is not desirable for the students to have free access to the equipment, drugs, or supplies.

The little amphitheatre is well worth the small space it occupies. It is usable for giving preliminary instructions, demonstration experiments, use of visual aids, discussions, and quizzes at the conclusion of the laboratory period.

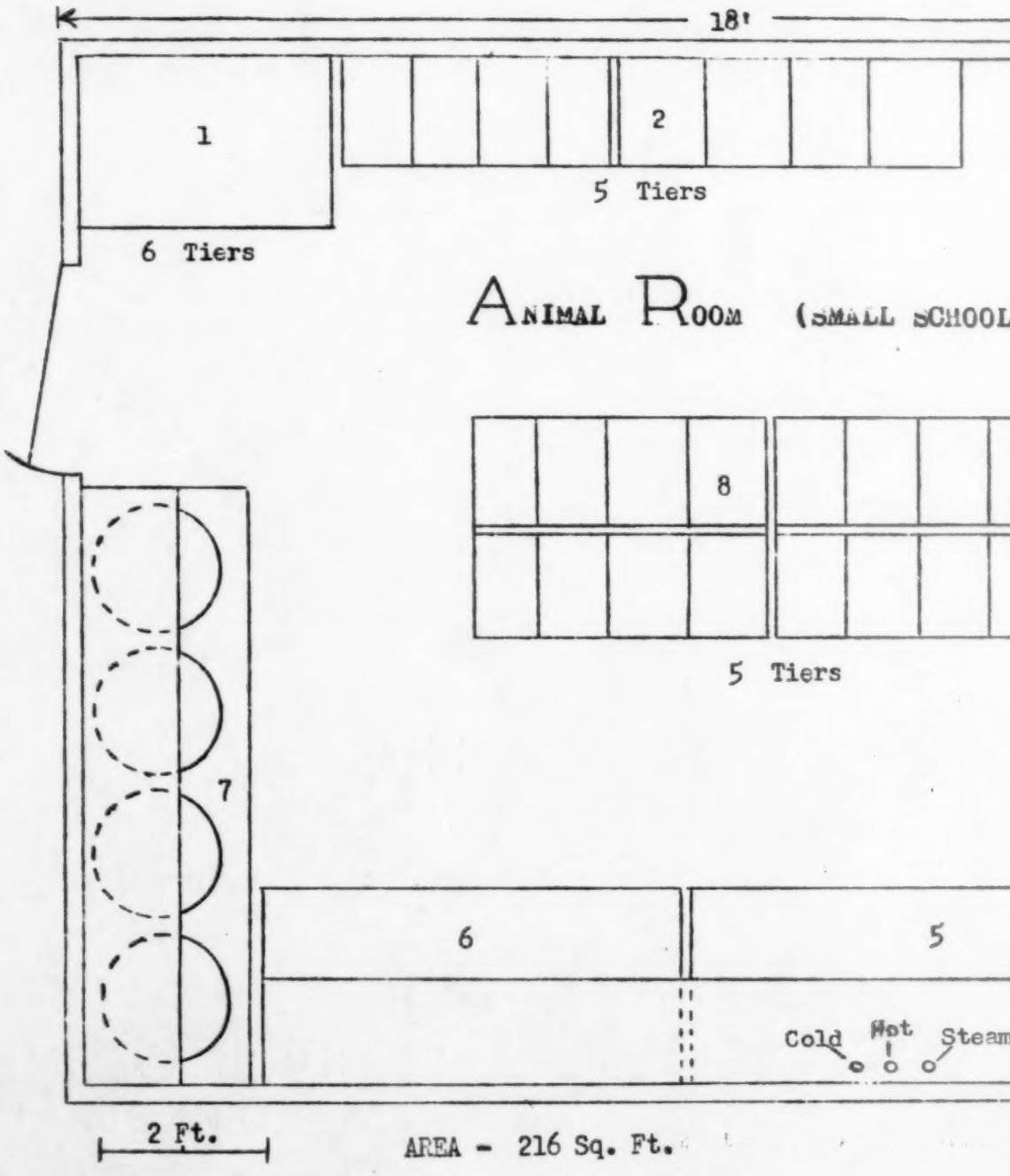
The type of laboratory desk shown is one that has been found quite satisfactory. Whether it is the stand-up or sit-down type is a matter of individual preference. Each desk should be provided with a small sink, preferably located at the end to give a large free flat working surface to the desk, and should be supplied with hot and cold water, electricity, gas, compressed air, and, if possible, connections to a central timing clock. Storage space is provided for such equipment which should be available for routine use.

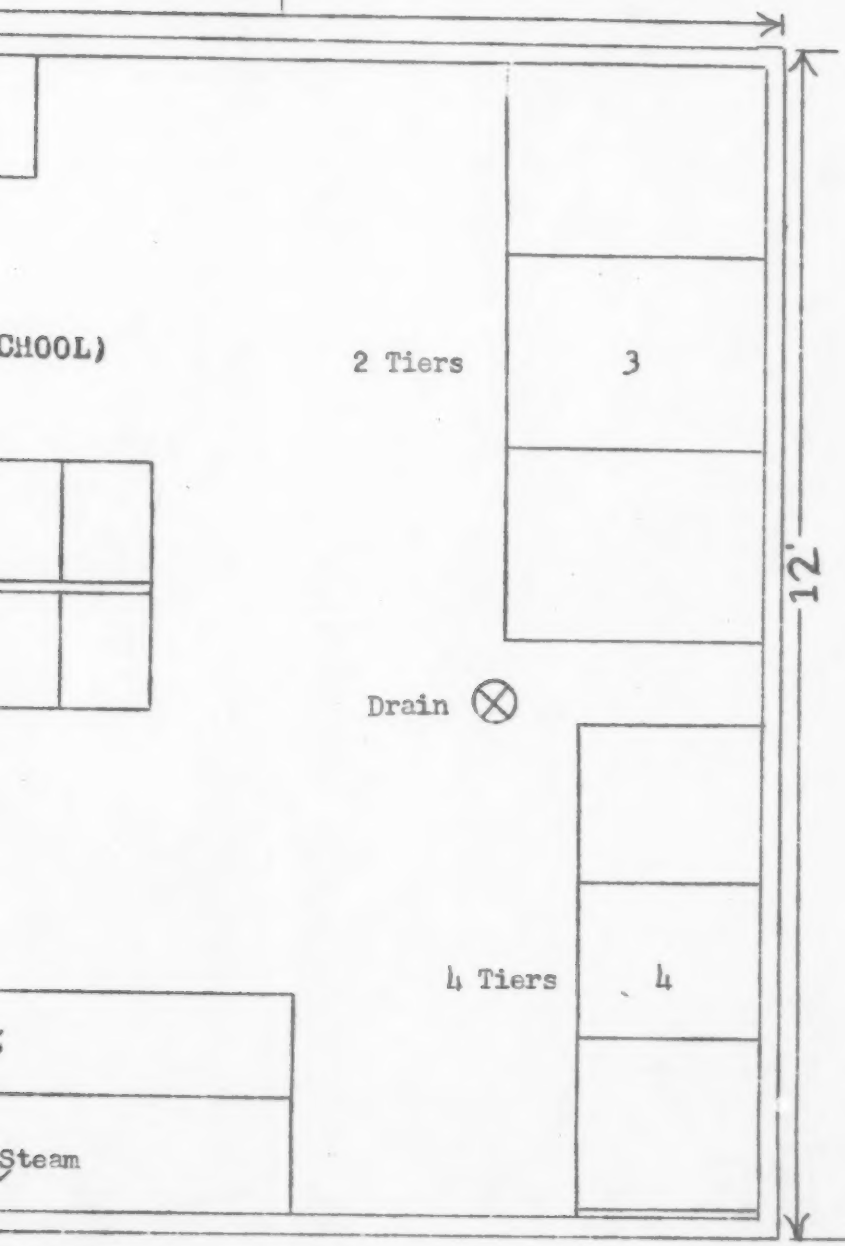
It is desirable, if possible, that separate rooms be provided for a kymograph room and a work shop room, for not only can better facilities be provided to serve the needs of these rooms, but it preserves the cleanliness and neatness of the laboratory proper by confining the necessary mess to the separate rooms. The details of the work shop are dealt with under a separate heading.

The laboratory described is equally adequate for both undergraduate and graduate formal instruction. However, another laboratory (or laboratories) should be provided for graduate research for the obvious reasons that a research program cannot be sandwiched between the teaching program and elaborate equipment setups cannot be assembled and unassembled constantly to make room for formal classes. The details of the plan submitted here for the research lab are omitted because the requirements of this laboratory vary with the program. However, the same general principles of planning suggested for the teaching laboratory are applicable, i.e., the mounting of equipment on portable tables and storage of equipment not in constant use.

Animal Room

The animal department is the biggest headache of all and the one requiring the most planning and care in operation. Without an adequate animal supply, no pharmacology laboratory can exist. The term "adequate" is used here advisedly because this adequacy is dependent upon a number of factors such as: (1) Available sources of animals; (2) Number of sections of each class required; (3) Whether a research program is maintained and the extent of same. Where only a limited research program is

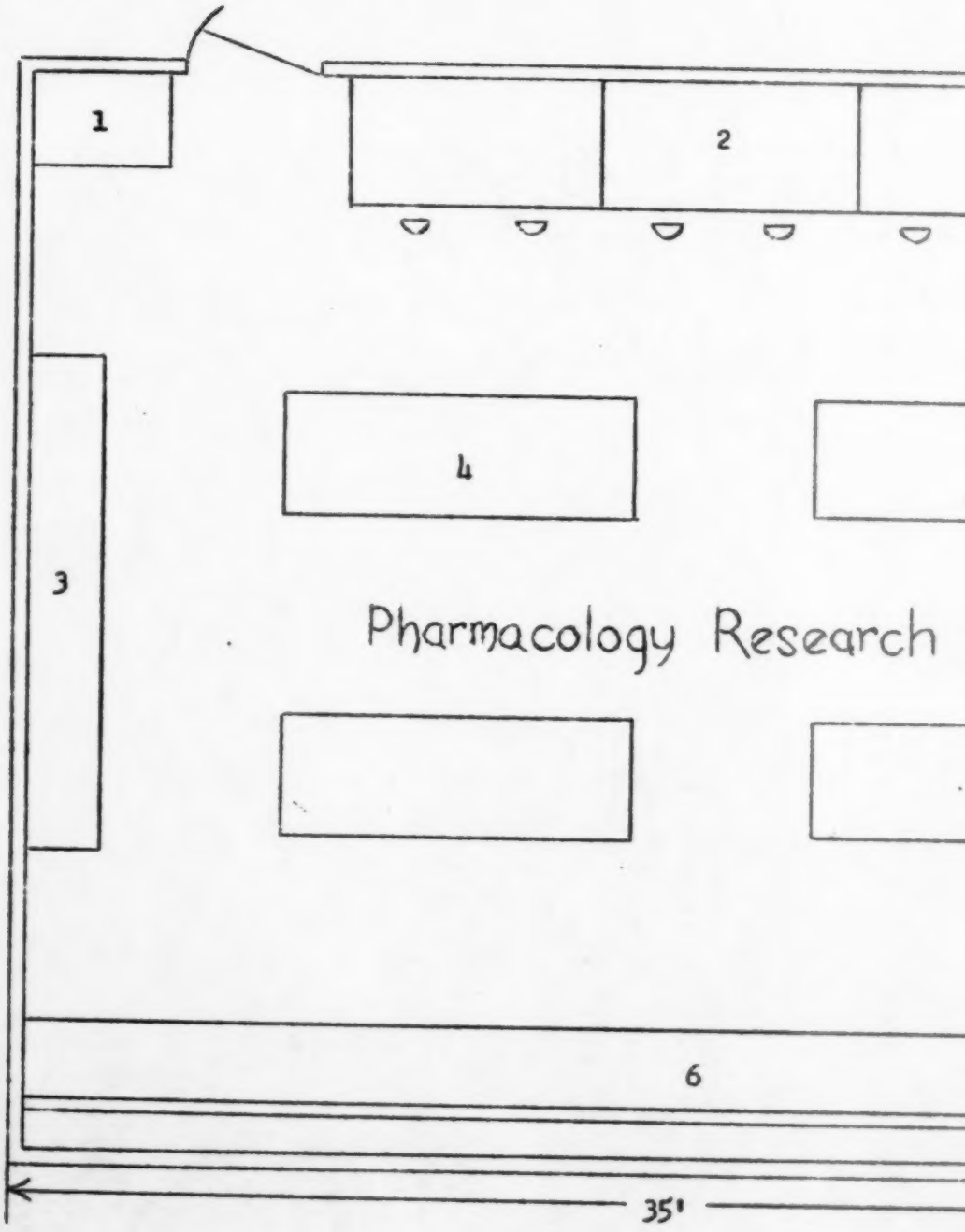

18'
1
2
5 Tiers
6 Tiers
ANIMAL ROOM (SMALL SCHOOL
8
5 Tiers
7
6
5
Cold
Hot
Steam
2 Ft.
AREA - 216 Sq. Ft.

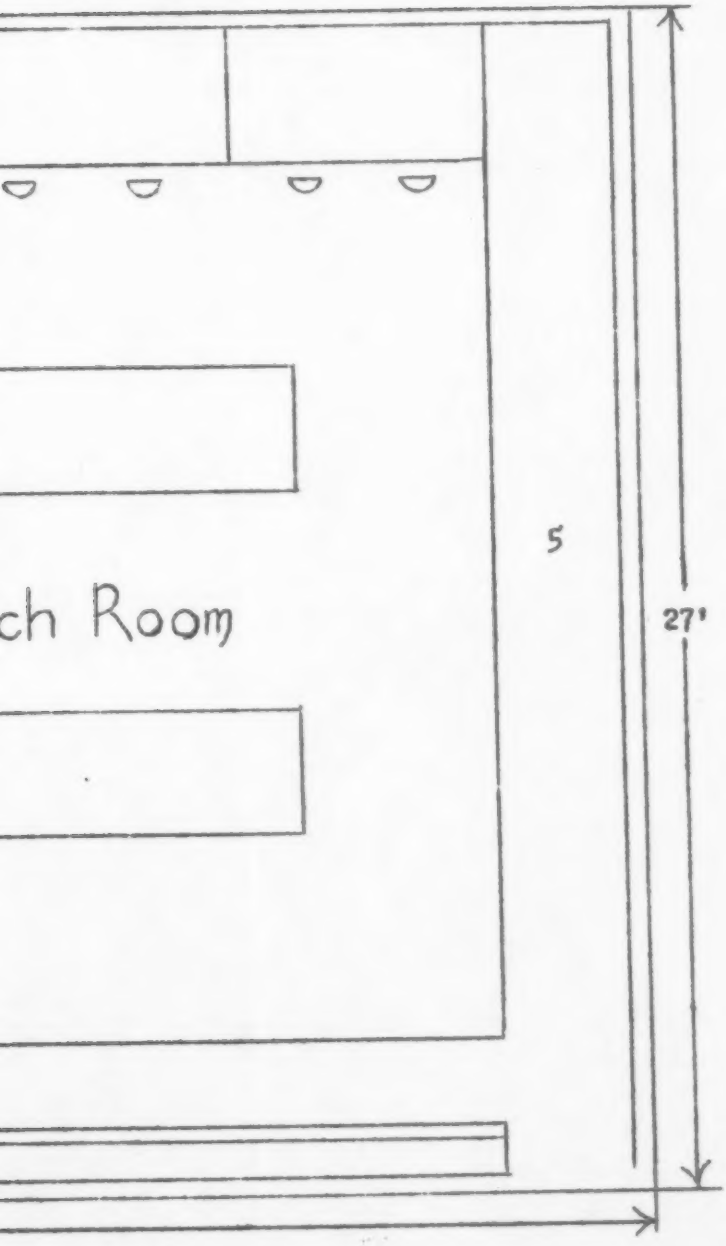


1. Guinea Pigs or Hamsters
2. Mice
3. Dogs
4. Rabbits
5. 6' Sink with storage space above it.
6. Work Table - storage space above and below
7. Food storage (garbage cans) with storage space above
8. Rats.

CAPACITY:

400 Mice
400 Rats
100 Guinea Pigs
24 Rabbits
6 Dogs


1
2
3
4
Pharmacology Research
6
35'



1. Refrigerator
2. Study Desk
3. Storage Cabinets
4. Work Table
5. Work Table
6. Chemical Type Work Desk

AREA - 945 Sq. Ft.

4 Ft.

carried on and a central supply of animals is available on the campus, then a relatively small animal room might be wholly adequate inasmuch as it serves only as a temporary storage room until the animals are used. On the other hand, if the sources of supply are distant, then only a room large enough to accommodate a much greater number of animals would be adequate. And this problem is multiplied directly by the number of sections of each class required in either case.

Cleanliness is the byword in the animal department and provisions must be made for washing and sterilizing racks, cages, and supplies. Storage space for supplies and food is a must. Controlled temperature and humidity and means of dispensing with animal odors must be given primary consideration. The location of the animal rooms should be convenient to the laboratories as well as to outside exits for convenience in bringing in animals and food and removing refuse and garbage. The rooms should be so constructed and arranged that they can be flushed down with a hose periodically.

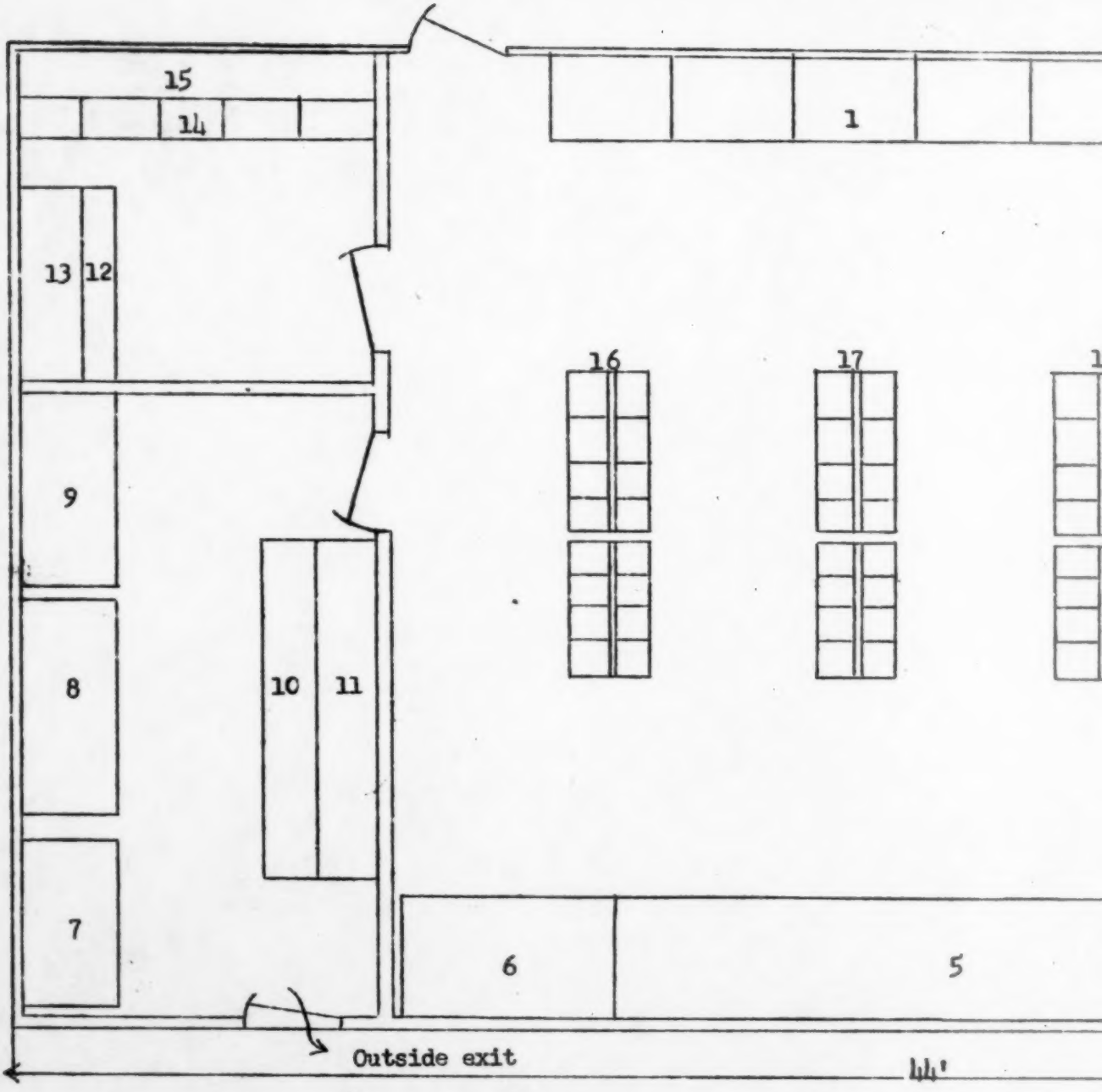
This paper is not supposed to be a discourse on the care and maintenance of the small animal laboratory, but the subject is of such magnitude and importance to the pharmacology department that I wish the Seminar committee had incorporated it into the program as a separate subject for discussion. The problems and pitfalls in planning the animal department are so many and varied in different areas under different conditions that I cannot even touch upon all of them. I believe that this department requires more planning than any other and fewer people are qualified to do this planning. I firmly recommend that no one should plan this department until he has studied some of the various pamphlets, books, and publications on the care of small animals until he is thoroughly familiar with the problems involved; in addition, considerable experience is desirable and, even then, it is wise to get additional expert advice.

If a research program is to be carried on in which animals must be maintained for relatively long periods of time, then separate rooms should be provided not only because of the additional space necessary but also because all animals do not thrive in the same environment. Mice, rats, guinea pigs, and hamsters should be separated from dogs, cats, rabbits, and fowl.

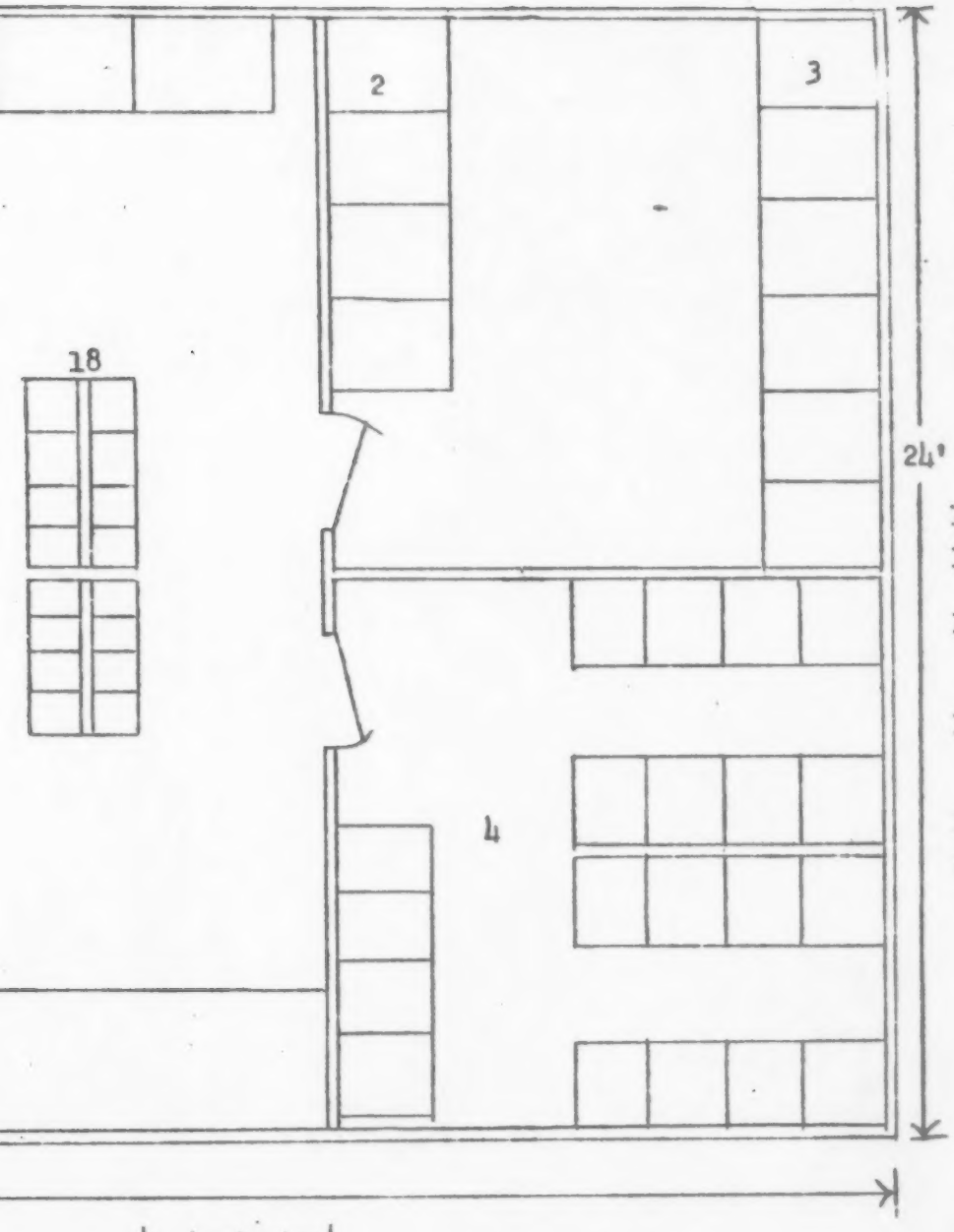
The greatest enemies in the animal rooms are vermin. Every means of combatting these should be provided for.

Work Shop

This is one of the most valuable assets a pharmacology laboratory can possess. The pharmacologist who is "all thumbs" with ordinary tools is at a decided disadvantage, if indeed he can be called a pharmacologist. The shop is not only useful for making equipment or gadgets for special purposes,but also it is a necessity for repairing equipment. And pharmacology equipment is almost always in need of repair: cage hinges break or need rewelding; modifications of metabolism cages become desirable; electrical points need replacing; set nuts freeze; etc. It is expensive and inconvenient to return equipment to the factory for such minor repairs, and the pharmacologist who is a fair mechanician and has a suitable shop not only will have more equipment because he can make things that are not available on the market, but also his equipment will always be in good working condition.



ANIMAL ROOM (LARGE SCHOOL)



1. Guinea Pigs and hamsters in cages 24" x 36"
2. Fowl
3. Dogs in cages 24" x 32" x 30
4. Rabbit room
5. Work table
6. Frogs (Refrigerator)
7. Sawdust bin
8. Sterilizer
9. Sink
10. Work table with
11. Storage space above the table
12. & 13. Work table with storage space above
14. & 15. Food bins with storage space above
16. Mice
17. & 18. Rats.

4 Ft.

1276 Square Feet.

The shop should be located off the laboratory and, while it need not be large, it is wise to provide sufficient space so it can "grow" parallel with the growth of the department as a whole. Sufficient storage space for "junk" should be provided inasmuch as it is amazing how useful and essential pieces of pipe, wire, boards, 2 x 4's, tile blocks, plywood, screen wire, sheet metal, etc., can become.

Summary

When I was assigned the subject, "The Physical Requirements for Pharmacological Instruction," and first started preparing this paper, I had ideas of working out and presenting very exacting and detailed plans for all phases of pharmacological instruction. I soon found this to be an endless task. In this presentation I have been able only to touch upon some of the major points to be considered in setting up a pharmacology department. Much of it might be said to be the application of "plain common sense"; however, it must be remembered that what we term "common sense" is actually a logical solution to a problem one is thoroughly familiar with. We have noted before that not many are familiar with the problems involved. Once a mistake has been made, it is quite easy to then see that "common sense" should have prevented that mistake. "Common sense" is a commodity that exists only when one is well informed on the problem in general. I have undoubtedly overlooked or omitted points which are problems for particular individual situations. I have intentionally omitted some points which I thought were purely matters of personal opinion.

It would have been very easy to let my enthusiasm run away with me and to have presented "ideal" plans. While I would not say that such "ideal" setups are impossible, I do say that they are generally very improbable. Therefore, I have tempered my "dreams" and attempted to stay well within the realm of probability. It seemed futile to place much emphasis on the exact relative location of the various rooms inasmuch as this is largely governed by the design of the building, and the arrangement must be worked out independently for each school accordingly. The main point to keep in mind, however, is that if possible the general utility rooms such as the kymograph room and the work shop should be so located as to serve both the laboratory and the research rooms. Similar plans should be kept in mind for the storage room and animal rooms.

These matters are largely architectural problems though and must be worked out individually. I would like to caution against one very common error. In an effort to gain efficiency through convenient inter-room access, all wall space is taken up with doors, windows, etc., leaving no space for cabinets, work space, shelves, sinks, etc.,--all of which results in a very inefficient laboratory.

It is with some trepidition that I present the plans for the laboratory and animal room for the "small" school for fear that they will be interpreted by some administrators as recommended plans when rather they are presented with an attempt to show what can be done by careful planning when space is limited.

The equipment lists presented are suggested only as guides as to what might be considered minimum requirements. Many types and varieties of equipment are available and the choice will vary with variations in individual preference and as the local designs and plans differ.

Again I would like to remind you that these plans are not presented here as "ideals," but rather as minimum essential physical requirements for a satisfactory pharmacology department.

APPENDIX

PHARMACOLOGY LABORATORY EQUIPMENT

Permanent Equipment in Each Lab Table

1 Animal Board
1 Frog Board with 6 Frog Clips
1 Turtle Board
1 Kymograph
2 Covered Animal Jars
1 Gooseneck Desk Lamp
2 Test Tube Racks
2 Ring Stands (Swivel Base)
4 2-Way Clamps
1 Set Beakers
12 Test Tubes
1 Box Absorbent Cotton
1 Spool Thread (White)
1 Ball String
1 Ball Heavy Cord
1 Bell Jar
1 Adjustable Stand
1 Bunsen Burner
1 Ring Stand (Heavy Base)

Other Equipment per Each Lab Desk

2 Heart Levers
1 Signal Magnet
1 Thermometer (Rectal)
6 Medicine Droppers
6 Serrafines
1 Hemostat (straight)
1 Hemostat (curved)
1 Dissecting Forceps (sharp)
1 Dissecting Forceps (blunt)
1 Dissecting Forceps (curved)
1 Scapel Handle with 6 Blades
2 Dissecting Probes
1 Bone Saw
2 Pulleys
1 Muscle Warmer
1 Time Market
1 Muscle Clamp
1 Flashlight (pencil type)
2 Recording Tambours
3 Arterial Cannulae (small, medium, large)
1 Industorium with Stimulating Electrode
1 Dissecting Scissors (large blunt)
1 " " (smaller, sharp)
1 " " (blunt, sharp)
1 " " (very fine)
1 Mercury Manometer (to record B.P.^{o})
1 Stethoscope
2 Dissecting Needles
1 Muscle Lever
5 Hypodermic syringes
1 1/2 cc. Tuberculin
1 1 cc. Tuberculin
1 2 cc.
1 5 cc.
1 10 cc.
12 Hypodermic Needles (assorted)
3 Tracheal Cannulae (small, medium, large)

General Equipment

Operating Tables
Kymograph Extensions
Platform Scale
Small Animal Balance
Analytical Balance
Chemical Balance
Instrument Sterilizer
Clinical Centrifuge
Paper Cutter
Mouth Gags
Ether Cones
Hair Clippers
Rabbit Boxes
Mouse Holders
Guinea Pig Holders
Rat Holders

Books

Experimental Pharmacology and Materia Medica, Jackson
A Manual of Pharmacology, Sollmann
The Pharmacological Basis of Therapeutics, Goodman and Gilman
Physiological Basis of Medical Practice, Best and Taylor

Apple I would like to remind you that those plans are not presented
here as "ideals," but rather as minimum essential objectival requirements
for a medium pharmacology department.

APPENDIX

SUGGESTED LABORATORY EQUIPMENT

Permanent Equipment in Each Lab Table

1 Ledged Board
1 Iron Stand with 6 Prong Clamp
1 Burette Stand
1 Aspirator
2 Covered Animal Cans
1 Dissecting Instrument Case
1 Test Tube Brush
1 Glass Funnel (Medium Size)
4 Petri Dishes
1 Rat Holder

Glass Fixtures on Each Lab Desk

2 Beaker Clamps
1 Ringed Funnel
1 Thermometer (Centigrade)
6 Medicine Droppers
6 Separatory
1 Graduate (Pyrex)
1 Beaker (Covered)
1 Graduate Pyrex (Short)
1 Graduate Pyrex (Tall)
1 Pyrex Flask with 2 Necks
2 Reagent Bottles (Pyrex)
1 Pyrex Tube
2 Pipettes
1 Burette Holder
1 Test Tube Rack
1 Beaker Clamp
1 Florence Flask (Small Size)
2 Separating Funnels
1 Graduate Cylinder (small, medium, large)

General Equipment

Operating Tables	Paper Cutter
Kymograph Cylinders	Mouth Caps
Platform Scale	Ether Cones
Small Animal Balance	Rat Slippers
Analytical Balance	Rabbit Boxes
Chemical Balance	Mouse Holders
Instrument Sterilizer	Guinea Pig Holders
Clinical Centrifuge	Rat Holders

12 Test Tubes	
1 Box Absorbent Cotton	
1 Spool Thread (White)	
1 Ball String	
1 Ball Heavy Cord	
1 Ball Jar	
1 Adjustable Stand	
1 Bunsen Burner	
1 Ring Stand (Heavy Base)	

1 Thermometer with Obstructing Sleeve	
2 Dissecting Scissors (large blunt)	
2 " " (small, sharp)	
1 " " (blunt, sharp)	
1 " " (very fine)	
1 Mercury Manometer (to record B.P.)	
1 Stethoscope	
2 Dissecting Needles	
1 Needle Lever	
3 Hypodermic Syringes	
1 1/2 cc. Tuberculin	
1 1 cc. Tuberculin	
1 2 cc.	
1 5 cc.	
1 10 cc.	
12 Hypodermic Needles (assorted)	
3 Tracheal Cannulae (small, medium, large)	

Books

Experimental Pharmacology and Materia Medica, Jackson
A Manual of Pharmacology, Solmann
The Physiological Basis of Therapeutics, Goodman and Gilman
Physiological Basis of Medical Practice, Best and Taylor

SHOP EQUIPMENT

Pliers (flat nose, sharp nose, wire cutting)
Hammers (claw)
Vise (small)
Files (flat, round, triangular)
Hand Saw
Electric Drill and Assorted Drills
Blast Lamp
Wrenches
Emery Wheel
Screw Drivers (regular and Phillips assorted sizes)
Hatchet
Anvil
Tin Snips
Hack Saw
Electric Soldering Iron
Brace and Assorted Wood Bits
Miter Box and Saw

SOURCES OF SUPPLY OF PHARMACOLOGY EQUIPMENT AND SUPPLIES*

Animal Cages and Animal Room Equipment

Norwich Wire Works, Norwich, New York
George H. Wahmann Mfg. Company, Baltimore, Maryland

Laboratory

A. S. Aloe Co., 1831 Olive St., St. Louis 3, Missouri
(General surgical and dental supplies)

American Instrument Co., 8010-8020 Georgia Ave., Silver Springs, Md.
(Chemical and biological laboratory instruments, bacteriological apparatus, electrical equipment, absorption cells, photometers, special instruments built for special purposes, etc.)

American Optical Co., Instrument Division, Buffalo, New York
(Microscopes, lenses, photomicrographic equipment, projectors, colorimeters, etc.)

Bausch & Lomb Optical Co., 642 St. Paul St., Rochester 2, New York
(Optical goods, balopticons, lenses, microscopes, and supplies)

Becton-Dickinson & Co., Rutherford, N. J.
(Veterinary and clinical thermometers, glass syringes, and hypodermic needles)

Carolina Biological Supply Co., Elon College, North Carolina
(General laboratory apparatus, living materials, dissecting instruments)

Central Scientific Co., 1700 Irving Park Blvd., Chicago 13, Illinois
(Scientific instruments and laboratory apparatus)

Chicago Apparatus Co., 1735 North Ashland Ave., Chicago, Illinois
(General laboratory apparatus and supplies for chemistry, physics, biology, and general science)

Clay-Adams Co., Inc., 141 East 25th St., New York City, New York
(Anatomical models, general laboratory equipment and supplies, chemical balances, etc.)

Denoyer-Geppert Co., 5235 Ravenswood Ave., Chicago 40, Illinois
(Models, charts, skeletons, slides, demonstration mounts of biological material)

Eberbach and Son Co., Ann Arbor, Michigan
(General laboratory apparatus and equipment for physiology, pharmacology, etc.)

Fisher Scientific Co., 711-723 Forbes St., Pittsburgh, Pa.
(General laboratory supplies and equipment, chemicals, etc.)

General Biological Supply House, 761 East 69th Place, Chicago, Ill.
(Biological supplies, aquarium plants, laboratory animals, "Turtox-products")

Gorrell & Gorrell, Haworth, New Jersey
(Electric long paper kymographs and accessories)

Harvard Apparatus Co., Dover, Massachusetts
(Physiological apparatus)

The Kauffman-Lattimer Co., Front and Chestnut Sts., Columbus, Ohio
(Scientific apparatus and laboratory supplies)

E. Leitz, Inc., 730 Fifth Avenue, New York City, New York
(Microscopes, cameras, projection apparatus, optical equipment)

Phipps & Bird, Inc., 303 S. 6th Street, Richmond 5, Virginia
(Tambours, heart levers, muscle levers, ink-writing instruments, kymographs, pneumographs, etc.)

Precision Scientific Co., 3737 W. Cortland Avenue, Chicago, Illinois
(Drums, electrically driven, for smoking long drum papers; Bunsen burners, etc.

E. H. Sargent & Co., 155 Superior St., Chicago, Illinois
(Scientific laboratory apparatus, chemicals, rubber tubing, etc.)

Arthur H. Thomas Co., West Washington Square, Philadelphia, Pa.
(General laboratory apparatus and equipment)

W. M. Welch Scientific Co., 1517 Sedgwick St., Chicago, Illinois
(Scientific instruments, laboratory apparatus)

The Will Corporation, 39 Russell Street, Rochester, New York
(Water baths, incubators, general laboratory equipment)

The Max-Wocher & Son Co., 29-31 West 6th St., Cincinnati, Ohio
(Surgical equipment, pharmacologic apparatus, artificial respiration machines, plethysmographs, myocardiographs, long paper kymographs, recorders for internal organs, cannulas, etc.)

Carl Zeiss, Inc., 485 Fifth Avenue, New York City, New York
(Microscopes, lenses, optical goods in general)

*For a more extensive list for special equipment or supplies, see Experimental Pharmacology and Materia Medica, Jackson, 2nd Ed., page 873.

Experimental Pharmacology and Materia Medica. Jackson, 2nd Ed., page 873.

PHARMACOLOGY AS TAUGHT TO PHARMACY STUDENTS IN A MEDICAL SCHOOL

E. G. Gross, State University of Iowa, College of Medicine,
Department of Pharmacology, Iowa City, Iowa

Early in my career, perhaps I questioned the status of pharmacology as a scientific discipline. Too often pharmacology was taught in the spirit of being a poor sister relative of biochemistry or physiology. Quite frequently the individual delegated to teach pharmacology was chosen by "laying-on of the hands" of someone from one of these departments.

The usual effect of such lectures upon the student was that "pharmacology" is a euphemism applied to a catalogue of chemical compounds in a feeble effort to dignify it as a science. No one was fooled - not even the instructor!

No doubt part of the explanation for this bad effect upon student morale in regard to pharmacology was basically due to the instructor's lack of conviction of the actually unique position of pharmacology with respect to the other sciences. But, as long as he himself felt it was a second choice, a little brother among the elder sciences, how could his lectures serve to inspire the better students toward a deeper interest. Undoubtedly a major portion of the intellectual lethargy which infected teachers in this subject over three decades ago was due precisely to the fact that no general organizing principle for viewing pharmacologic effects was well developed. One recalls that it is largely through the last three decades that we have seen the full development of the idea of a receptor (i.e., in the field of enzymology) and that heretofore the pharmacologist possessed only an *a priori* conjecture as to the existence of these primary drug sites of action as envisioned by Paul Ehrlich through his studies on dyes and arsenicals. In the wake of the refinement of this phase of biochemistry one sees the fruitful realization of Ehrlich's ideas richly illustrated, first, through researches on the sulfonamides and later the ramification of the notion of chemical constitution versus pharmacologic action relationships toward ever wider applications.

In short, the isolation and characterization of enzymes forms the key-stone as it were for pharmacology since until the recognition of just what a receptor was, pharmacology lacked any notion of the real nature of the primary sites of drug activity. Small wonder that a discipline, so emasculated could inspire the instructor. Before the advent of these basic ideas and the full bloom of the principle of drug specificity and receptor interaction, pharmacology surely gave the impression of a catalogue of facts and lacked that touch-stone which makes a science live and appeal to the intellect as a thing of beauty - namely, a developing sense of the presence of design and orderly relationship.

It is true even today that the pharmacologist draws upon the technique and scientific doctrine from all other fields - from mathematics and physics, up through chemistry, biochemistry, cytology, histology and physiology. Indeed, he may on occasion be particularly interested in the results of the psychologist, psychiatrist and even the sociolo-

gist - this later when medico-legal questions are at hand. Thus, it would appear that, except for his developments in the field of bioassay, the pharmacologist himself contributes little to the establishment of new techniques in the field of pharmacology. What then does the pharmacologist possess which gives him and his field individuality? A little reflection and I think you would agree that it is the truly unique role that pharmacology plays in integrating our knowledge of special drug effects in all their great variety in regards to site of initial interaction with body constituents, mechanism of interaction with these primary sites, and finally an orderly way of viewing the propagation of the initial effect up through the various biochemical, cytological, histological levels so that the end effects - be they harmful or beneficial - can be viewed in an organized sense connected with the interactions of the drug itself. Thus, the pharmacologist must be thoroughly competent in his theoretical knowledge and rich in his experimental qualifications to cut across the many levels between the initial interaction of the drug after administration and its final effects on the whole organism. Moreover, he cannot be merely a good physiologist as such and a good biochemist, but must see the intimate relationships between these fields since in the interpretation of drug action propagation he must be trained to connect the experimental results of one level of research to the next.

Finally we see that a biochemist or physiologist may be very successful in developing new methods and concepts toward the broadening of his given level of research in a horizontal sense but it is the task of the pharmacologist to unite the information gathered on all levels and to form it into a strong vertical structure capable of being used in the interpretation of drug action all the way up and down through the stratified structure of science itself.

The question of teaching a first course pharmacology to students which will make use of drugs in one or more different fields as in pharmacy, in dentistry, in medicine, or as research workers in pharmacology or other basic biological sciences does not present a difficult problem in course design.

As a particularly special case the pharmacist who serves the community, either in private enterprise or a hospital, or eventually accepts a position with industry must necessarily have not only a broad and fundamental knowledge of drugs and their actions as applied in medicine but also in dentistry, veterinary medicine, entomology, pest control and industrial toxicology - to mention only a few. It is, therefore, obvious that a first course in pharmacology could not possibly approach the degree of specialized knowledge required of a pharmacist well trained in all the areas he will be called upon to serve. A similar agenda of special topics could be appended for the dentist or the physician and these in turn would vary depending on whether he specialized in dental surgery, anesthesiology, or internal medicine, etc.

The only thing, therefore, in my sincerest opinion, that a first course in pharmacology for any of these special fields can hope to secure in regard to the actions of drugs is a knowledge of the basic subject matter of pharmacology itself - 1) the elucidation of the relationship between dose and effect and between time and concentration, 2) the localization of the sites of action of general classes of agents together with

major organ and organismal responses evoked, 3) a general idea of the mode of propagation of the drug effects within the organism. For the pharmacist special use of his superior knowledge of chemistry may be used to good advantage in emphasizing the relationship between the chemistry of general pharmacologic classes of drugs so that as new agents are placed on the market he has been so oriented that he will readily visualize the chemical and pharmacologic position of the new agents against his fundamental background. Some special emphasis must be made in regard to drug toxicology and he may receive a wider idea than the medical student as to the actions of insecticides, rodenticides, and veterinary pharmaceuticals. In the main, however, his first course cannot deviate very much from the basic plan which will be a common denominator for the dentist, medic, veterinarian which he will have to serve. We, however, hold no brief with the old idea that pharmacists should learn as little as possible of pharmacology in order to discourage over the counter prescription. We believe indeed that the more a pharmacist knows concerning the potentialities of drugs the more cautious he will be in these regards.

The last, but most important objective should be the securing of the student's interest in drugs through pharmacology as a theoretical and practical tool that will give him the incentive for more detailed study. This latter may be pursued in the form of advanced courses or through his own independent study.

If you were to compare the number of hours offered between our course in the medical college and that offered to the pharmacy students you might wonder why we offer fewer hours to the latter group, when we apparently are pointing to an equally comprehensive course in pharmacology for pharmacists. Actually this disparity is not too significant, when one considers the somewhat different emphasis we place upon the two courses. At Iowa we do <u>not</u> include prescription writing in the pharmacy course in pharmacology, as this material is adequately covered within the college of pharmacy, and somewhat less emphasis is placed upon therapeutics. The therapeutic applications of drugs are not emphasized to the pharmacy student, except where these therapeutic uses are based on generally recognized and definite pharmacological actions. Further they are confined to such diseases as a pharmacy student could be expected to know something about. Such practical applications always lend interest in any course of study. An additional reason for the decreased emphasis upon therapeutic applications, which is the major difference between the courses, derives from the fact that the pharmacy students, in general, do not possess the background in physiology and anatomy commensurate with the medical background while the medical people are weak in chemistry. However, toxicology of drugs is treated equally in both the pharmacy and medical course. It is obvious that this phase of pharmacology cannot be considered comprehensively, except in a special toxicology course. Nevertheless, we do attempt to give the student a working knowledge of both symptomatic and specific treatment of the more common poisons, whether the poisoning occurs in man or animal. When we deduct prescription writing and a lesser emphasis on therapeutics from the medical course the actual hours devoted to pharmacology between the two courses do not show any great discrepancy. In fact we insist that graduate people from other departments, minoring in pharmacology, take the pharmacy course in preference to the medical course. The pharmacology course at our institution, for pharmacy students, consists of four lecture hours and one laboratory period per week for one semester. In the lecture work we attempt to cover the more important groups of drugs with emphasis upon the general mode of action of given

classes. The details are imbedded in the general background already described as basic for any beginning course. We make special use of the pharmacy student's knowledge of chemistry to emphasize the similarities between drug structure and their activities as this is a useful mode of helping him to organize and remember the details concerning pharmacologic activities. Such a mode of approach through chemistry is not so successful with the medical people due to their lesser knowledge of chemistry and because the organization in their practice is more suitably organized around the therapeutic usefulness of the agents in question.

In the selection of staff for teaching the pharmacist, we use the same staff that teach our medical courses. I am adverse to designating a particular course to a single individual and restricting his teaching activities to only this group of students. To develop a sound course the instructor must be adept in teaching any of the general courses offered within a pharmacology department.

It may be argued that the type of laboratory work for pharmacy students should consist mainly of the bioassay type experiment. We do not hold to this thesis at Iowa, but rather that the laboratory should be so planned that at the end of the course, the student has had an opportunity to study the important representatives of most of the important drug classes discussed in the course. Obviously the demonstration of the actions of some of the important groups cannot be accomplished as acute experiments and laboratory time is a limiting element. Examples of such drugs might be cited as the vitamins and hormones. In the main, we utilize the same experiments for pharmacy students that we use in our medical course. At the first laboratory session the student performs a quantitative assay of histamine on the guinea pig gut strip. This experiment accomplishes the following purposes. It introduces the student to the quantitative assay of a drug, it employs certain statistical calculations and also emphasizes that biological variations exist. The latter point is extremely important in their understanding of subsequent laboratory work.

In other respects we have certain strong feelings about the conduct of laboratory work. First, the laboratory exercise must emphasize a clear cut point in regard to drug action. Secondly, the experiment must be a sure fire experiment. Students are not expert laboratory technicians and this statement applies as aptly to the medical student as to the pharmacy student. There can be no place for complicated laboratory exercises that can only be performed by expert laboratory technicians who have become skilled in a given operation by repeated trials. If such experiments are deemed pertinent they should be performed as demonstration exercises by the staff. In my own experience nothing is more discouraging to a student in a pharmacology laboratory than to end the day with results of doubtful value. It just doesn't set well with the student to tell him, well "you're just clumsy" it works fine if you would follow all the directions. All too often it has also failed in the instructor's hands. I am a firm believer in allowing the student to perform as many of the laboratory exercises as possible. The best arranged demonstration exercises cannot hold the attention of the student during an entire laboratory period. Frequently there are waiting periods in demonstrations and this leads to a lack of attention, on the part of a student. While it has been a long time since I was a student, I still have vivid recollections of the uncomfortableness of a stool over a two or three hour period. I am sure my attention was directed more to my backside than to the demon-

stration at hand. Thus, if demonstrations are given at all, they should be of the short and easily seen type.

If the student carries out the major part of his laboratory work in conjunction with a partner, he necessarily wants to obtain good results. To obtain good results he must be equipped with the best type of equipment one can provide, so that poor results can never be explained on the basis of inadequate equipment. We at Iowa are fortunate in this respect, in that my predecessor was a firm believer in this principle, thus we inherited very fine student equipment. This equipment serves for all classes in pharmacology and we feel that our results justify the expense of such equipment.

Another point about laboratory that I should like to stress, is that the student arrives at the laboratory to learn something about pharmacology, rather than to become a technician. Too often students spend nine tenths of their laboratory time getting set up for the experiment and one tenth actually performing the experiment. At Iowa, we completely set up the experiment before the class arrives, thus the student is devoting his time to the one tenth rather than the nine tenth time in gadgeteering.

Another point I should like to speak briefly about is the value of laboratory write-ups. I class laboratory write-ups with an old story of my former professor of anatomy. Each year the students were required to make a drawing of the various levels of the nervous system. He remarked one day that even after 40 years he recognized features in the student's drawings of his original drawing. It doesn't require much effort to find that notebooks resemble past years' editions almost word for word. We no longer require laboratory write-ups, but devote time to informal discussions and frequent short written laboratory exams. I believe it keeps laboratory from becoming the cook-book type of exercise, i.e., something you do to get through the course, but no one ever gives it any further thought.

Personally, I have had no experience at an institution wherein the non-medical student is not taught pharmacology within the medical school faculty. However, I believe that there are certain advantages in performing the teaching of non-medical students by a medical school department. First, a medical school usually has adequate space and facilities. Secondly, the close contacts with the various allied departments of the pre-clinical years and the opportunities afforded by a close contact with a teaching hospital, keeps the staff well geared to all the advances in the medical field. I can envisage only one disadvantage, that being in a medical department, individuals may tend to treat the non-medical course on much lower level than the medical course. It is my feeling, however, that unless a subject is well taught it should not be taught at all.

In summary, I should like to say that the question of teaching pharmacology to non-medical students within a medical school does not resolve itself into offering the non-medical student, such as the pharmacist, a short elementary course, but rather it should be comparable in scope to the regular medical course, with perhaps less emphasis on the therapeutic side of pharmacology. The fundamentals of a beginning course in pharmacology are the same whether the students be pharmacy, dental or medical students. To teach pharmacology on this level, then the instructor must be a capable pharmacologist, and one that devotes all his time to pharmacology, so that he keeps abreast of all the newer developments in his field.